ECONOMIC ADVISORY COUNCIL

CHANNEL TUNNEL COMMITTEE

REPORT

Presented to Parliament by Command of His Majesty, March, 1930

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REPORT.

I.—INTRODUCTORY.

(a.) Composition and Terms of Reference.

1. On the 5th April, 1929, the Prime Minister (Mr. Baldwin) appointed a Sub-Committee of the Committee of Civil Research,* with the following Terms of Reference :—

> To examine and report on the economic aspects of proposals for the construction of a Channel Tunnel or other new form of cross-Channel communication.

2. The Committee is composed as follows :—

E. R. Peacock, Esq. (*Chairman*).
The Right Hon. Lord Ebbisham of Cobham, G.B.E.
Sir Clement D. M. Hindley, K.C.I.E.
Sir Frederick W. Lewis, Bt.
Sir Henry Strakosch, G.B.E.

T. Jones, Esq., C.H., Secretary, Economic Advisory Council
A. F. Hemming, Esq., C.B.E., Assistant Secretary to the Economic Advisory Council
} *Joint Secretaries to the Committee.*

(b.) Procedure adopted by the Committee.

3. On the 12th April, 1929, we held a preliminary meeting for the purpose of laying down the procedure to be adopted in our Inquiry. We decided to pursue concurrently our examination of proposals for a Channel Tunnel and those for other new forms of cross-Channel communication. As regards the latter, some schemes, notably those for Channel Ferries, were immediately brought to our attention. Others were submitted to us at later stages of our inquiry. In each case we studied carefully the material placed at our disposal, and, where it appeared to us desirable, obtained reports thereon from our advisers.

4. As regards the proposals for a Channel Tunnel, we decided to obtain, in the first instance, from the Departments of State such information as was available from official sources. Thereafter we obtained evidence from the Channel Tunnel Company regarding

* Note.—By Treasury Minute dated January 27, 1930, the Committee of Civil Research was absorbed in the Economic Advisory Council, of which this Sub-Committee became a Committee.

the nature of their scheme (paragraphs 45–47) and from the unofficial Channel Tunnel Parliamentary Committee, which, under the Chairmanship of Sir William Bull, had done much to bring their proposals to public attention.

5. At the same period we received preliminary evidence on the geological aspects of the question and on the engineering and other technical problems involved. On this side of our Inquiry, we had anticipated that a large amount of data would be readily available, having regard to the number of years during which proposals for a Channel Tunnel have been under discussion. We found, however, that this was not the case. It appears that the promoters in this country and in France did not feel justified in incurring any further expenditure on exploratory work after the decision in 1883 by Her Majesty's Government to withhold, on military grounds, their authority for the scheme to proceed. As a result, the information placed at our disposal was neither full nor conclusive and many of the estimates submitted necessarily lacked detailed confirmation.

6. For the purpose of our Inquiry it was, however, essential that we should obtain adequate material with which to satisfy ourselves on the question whether the geological conditions of the bed of the Channel were such as would render it physically possible to construct a Tunnel; if so, whether the engineering difficulties likely to be encountered were such as might reasonably be anticipated it would be possible to overcome; and assuming that the answers to the foregoing questions were in the affirmative, what would be the probable cost of constructing and operating a Tunnel.

7. On the answer to the last of these questions must depend any conclusions on the question whether a Tunnel might be expected to compete effectively for traffic with existing routes, at reasonable rates, having regard to the heavy standing charges which it would have to meet. The eminent engineers and contractors who appeared before us were not in a position to do more than express their individual opinions on these questions; and it soon became apparent that reliable answers thereto could only be obtained after a considerable amount of detailed and expert investigation. Such investigations would entail substantial expenditure which no witness could reasonably be expected himself to incur for the benefit of our inquiry. We therefore concluded that the only means by which we could secure information on these matters would be for His Majesty's Government to arrange for a Report thereon to be obtained from a firm or firms of Consulting Engineers.

8. We recommended that the Consulting Engineers should be asked—

(1.) To examine and report on the scheme put forward by the Channel Tunnel Company for a railway connection between the Southern Railway and the Chemins de Fer du Nord under the Channel. The examination desired is of a general character,

and only sufficient to enable the consulting engineers to express an opinion on the following questions :—

(*a.*) Is a Channel Tunnel feasible from the point of view—

(i) of construction and maintenance?

(ii) of operation?

(*b.*) Is a pilot tunnel necessary or advisable, and how long would it take to construct?

(i) Is further exploratory work required before beginning work on the pilot tunnel?

(ii) If so, what further work should be done, how long would it take, and approximately how much would it cost?

(*c.*) If and when a pilot tunnel had been successfully made, would it be possible to estimate for the main tunnel, with reasonable certainty as to time, cost, and any unusual difficulties to be overcome?

(*d.*)—(i.) The Promoters and the Southern Railway Company suggest that £5,000,000 would cover the cost of constructing a pilot tunnel with a diameter of 10 feet, and £25,000,000 that of two traffic tunnels with a diameter of 18 feet 6 inches, of a total length of 34 miles* (including 12 miles of approach tunnels). This estimate does not include provision for the cost of constructing the exchange stations at each end of the Tunnel or the cost of the electric locomotives.

Are you able to say that this is a not unreasonable estimate?

(ii.) The Chemin de Fer du Nord have informed us that, in their view, if the Fougerolles, or some similar, method were successfully adopted for disposing of the excavated material, the cost of constructing the traffic tunnels would be reduced to (say) £18,000,000, and the period of construction to five years from the date on which work on them was started.

Do you consider this system to be a practical one and these estimates to be well founded?

(iii.) The Promoters allow the sum of £1,000,000 per annum for the operation and upkeep of the Tunnel.

Assuming that the rolling-stock and electric locomotives will be owned and maintained by the operating Railway companies, is this sum, in your view, sufficient to cover all costs under this head?

(*e.*) How many men per annum would probably be employed (*a*) directly and (*b*) indirectly in the construction of the pilot and main tunnels, respectively?

* This length should be 36 miles.

(2.) To report generally on the problems connected with the interchange of rolling-stock between the railways of Great Britain and those of the continent, both for goods and passenger traffic.

9. We felt that it would be invidious to invite any one firm of Consulting Engineers to express a definite opinion on the foregoing questions, in view of the complexity of the problems involved and the very large sums of capital that would be at stake. We therefore recommended that the task of preparing the proposed Report should be entrusted to a panel composed of the following firms of Consulting Engineers: Messrs. Livesey, Son and Henderson, Messrs. Mott, Hay and Anderson, and Messrs. Rendel, Palmer and Tritton.

10. Our recommendations were accepted by His Majesty's Government, and on the 6th December, 1929, we received a Report signed by the firms named above. This Report, which has proved of very great value to us, is reproduced as Appendix I to our Report.

11. On the subject of the traffic prospects of a Channel Tunnel we obtained evidence from the railway companies directly or indirectly interested in the proposal. The Companies directly affected are the Southern Railway of this country and the Chemin de Fer du Nord of France. We also received information on a number of points from the Secretary of the Railway Research Service. We obtained evidence from the Air Ministry regarding the growth of air travel between this country and the Continent.

12. We also took steps to inform ourselves of the effect which the construction of a Tunnel might be expected to have on employment in this country. As regards its effect on agriculture, we received evidence from the Minister of Agriculture and Fisheries. We had also the benefit of the views of the National Farmers' Union. Turning to the probable effect of a Tunnel on manufacturing and trading interests, we invoked the assistance of leading representative bodies and directly or indirectly consulted a large number of Chambers of Commerce. As regards Channel shipping, we obtained evidence from the Chamber of Shipping of the United Kingdom. We also took steps to obtain the views of bodies such as the Dover and Folkestone Harbour Boards, the revenue of which might be expected to suffer as the result of the construction of a Tunnel. Finally, two witnesses appeared before us to give evidence on certain social and other indirect effects which they feared might follow the construction of a Channel Tunnel.

13. We held twenty-five meetings for the purpose of taking oral evidence. A full list of the witnesses is given in Appendix II to this Report. In addition to the evidence taken orally we received a large number of written communications, including memoranda on particular aspects of our Inquiry furnished to us by the Board of Trade, the Ministry of Transport, the Home Office, the Foreign Office, the Admiralty, the Department of Overseas Trade and the Board of Customs and Excise.

14. We desire to place on record our indebtedness to all who have assisted us in our Inquiry, whether by giving oral evidence before us or by furnishing memoranda.

(c.) Arrangement of Report.

15. Our terms of reference are divided into two branches, the first dealing with proposals for the construction of a Channel Tunnel, and the second with other proposals for new means of cross-Channel communication. In preparing our Report we have thought it convenient first to give a survey of the history of the proposals of both classes that have from time to time been put forward in the past (Section II). We then deal in detail with the various proposals that have been brought to our notice for improving cross-Channel communications otherwise than by the construction of a Channel Tunnel (Section III).

16. In Section IV we outline the present proposals for the construction of a Channel Tunnel. Section V deals with the geological and engineering problems involved. In Section VI we consider the traffic problems involved in these proposals. Section VII is devoted to an examination of the economic aspects of a Channel Tunnel. In Section VIII we refer briefly to certain miscellaneous considerations, some of which we feel do not fall within our terms of reference, but all of which will require at some stage to be carefully considered by His Majesty's Government.

17. In Section IX we give a general survey of the evidence that we have received. Our principal conclusions under both heads of the Inquiry are summarised in Section X.

II.—HISTORICAL SURVEY.

(a.) Early History.

18. Suggestions for the construction of a submarine tunnel between England and France were made by Monsieur Mathieu as far back as the year 1800, but the first direct proposal for carrying out such an undertaking was not put forward until April 1867, when certain English and French gentlemen submitted preliminary plans to the Emperor Napoleon III. At the Emperor's suggestion, an International Committee was appointed with a view to drawing up a scheme. The outbreak of war between France and Prussia in 1870 put a stop for a time to the progress of the work, but, on the conclusion of peace in 1871, various schemes were set on foot with a view to improving Channel communications between England and France. These plans included schemes for bridges, steam ferries, tunnels and powerful steam vessels, with improved harbour accommodation. While these various plans were being discussed, the promoters of the Channel Tunnel scheme pressed on with their idea. The English Committee obtained an Act of Incorporation under the title of The Channel Tunnel Company, Limited. Great

efforts were made to obtain from Her Majesty's Government an expression of opinion on the tunnel scheme; it was not, however, till June 1872 that the British Ambassador in Paris was authorised to inform the French Government that, subject to certain reservations as to its practical working, Her Majesty's Government saw no objection in principle to the scheme for a Channel Tunnel. In 1875, the British Channel Tunnel Company obtained a local Act of Parliament (Channel Tunnel Company, Limited, Act, 1875) which empowered them to acquire land near Dover for the purpose of carrying out the objects for which they were incorporated. At the same period a concession was granted by the French Government to the French promoters, which laid down certain conditions on which the tunnel was to be constructed. Simultaneously a law was passed to carry out this concession or "convention" as it was called.

19. At this stage a joint Commission was appointed by the British and French Governments to consider the bases upon which a Treaty should be concluded upon the subject between the two countries. The Commissioners met in Paris and London in 1875, and on the 31st May, 1876, submitted a joint report to which was attached a memorandum or *projet* in which was embodied the bases upon which they recommended that a Treaty should be concluded between England and France. That *projet*—which was laid before Parliament—contained many important clauses. Clause 1 defined the boundary between England and France *in the Tunnel* as half-way between low-water mark (above the Tunnel) on the coast of England and low-water mark (above the Tunnel) on the coast of France. By another clause (Clause 12) it was suggested that either Government might, after thirty years, purchase the undertaking; and by another (Clause 15) that each Government should have the right not only to suspend the working of the Submarine Railway and the passage through the Tunnel whenever it should, in the interest of its own country, think necessary to do so, but also to destroy the works, by flooding or otherwise, without granting any *compensation* for damage, other than that which in its discretion it might think proper to pay to the Company established in its own country. As regards the operation and inspection of the tunnel, the *projet* proposed (Clause 4) that the two Governments should constitute an International Commission of six members, of whom three should be nominated by each of the two Governments. This Commission should advise the two Governments on all questions relating to the construction, maintenance and working of the submarine railway, which it should have power to inspect. The Commission should be bound every year to submit a report to the respective Governments, both on its own proceedings and on questions connected with the submarine railway. It was further proposed that the Commission should submit to the two Governments its proposals for supplementary Conventions with respect to: (*a*) the apprehension and trial of alleged criminals for offences committed in the tunnel

or in trains which had passed through it, and the summoning of witnesses; (*b*) customs, police and postal arrangements and other matters which it might find convenient to deal with.

(b.) Geological Investigations.

20. While the negotiations referred to in the preceding paragraphs were in progress, a number of geological investigations were undertaken with a view to laying down a line for the proposed tunnel. The first French engineer to study the question was Monsieur Thomé de Gamond, who, in 1866, proposed that the tunnel should be driven through the Wealden and Oolitic formations of the Jurassic system between Folkestone and Cape Grisnez, passing in its course under the Varne sandbank, which lies nearly midway, in a direct line, between the English and French coasts. His proposal was to sink a shaft on the Varne itself and a shaft on each side of the Channel, so that the work could be carried out from four faces instead of only two, and so shorten the time of construction. In England, Sir John Hawkshaw was the first engineer seriously to study the geological question. In 1865 he employed Mr. Hartsink Day to make a careful study of the cretaceous and underlying beds on the English and French coasts. The particular value of this survey was that it showed conclusively that the chalk overlying the gault is almost identical on the two coasts. In order to ascertain the nature of the strata composing the sea bed a special sounding apparatus was designed. From an examination of the specimens brought up by its means from the sea bottom it was claimed that the survey proved the continuity of the cretaceous beds across the channel from side to side. Sir John Hawkshaw was not, however, satisfied in having only established the identity of the beds as exposed on the cliffs on each side of the Channel and their superficial continuity on its bed. He therefore decided that it was necessary to ascertain by actual borings on each coast whether the thickness of the lower beds of chalk which had been measured in the cliffs on each side was in fact maintained after the lower beds had disappeared beneath the sea. He accordingly put down two borings. One was sunk at St. Margaret's Bay, about 4 miles east of Dover, and 8 miles east of the outcrop of the lowest chalk bed on the English coast, and the other on the French coast at Ferme Mouron, 2½ miles west of Calais and 4 miles east of the outcrop of the same bed on the French coast. These borings showed that the thickness of the lower chalk does not diminish to any material extent as it is followed eastwards from the outcrop.

21. In 1875, the newly-formed French Tunnel Company proceeded to make an extensive and more elaborate survey than that which had already been carried out by Sir John Hawkshaw. The Company took some 7,000 soundings in the Channel and obtained a large number of specimens (3,760) from the bottom of the sea. The French geologists by whom this material was examined

claimed that they could identify to which particular strata the specimens belonged and that from this information they were able to plot with some accuracy the junction of the lower chalk and the gault from shore to shore except for a short distance where those beds pass beneath the sands of the Varne near the middle of the Channel. The Company also put down at this time a boring at Sangatte, and a little later sank two shafts and drove headings in different directions through the lower beds of the chalk, a little to the west of Sangatte, for the purpose of defining the position of those beds and the gault.

22. In August 1880, an application was made by the French Company for an extension of their concession, which had lapsed, as no arrangement had been reached with an authorised British Company. At the same period, the South-Eastern Railway Company obtained powers (South-Eastern Railway Act, 1881, Section 43) to acquire land for the purpose of experimental borings and other work in connection with the construction of a Channel Tunnel. The Company also carried out certain experimental work between Folkestone and Dover, where three shafts were sunk, one near Abbots Cliff, one near Shakespeare Cliff, and a third to the east of Shakespeare Cliff. Headings were driven from the first two shafts in a direction more or less parallel with the cliff, through the lower beds of grey chalk, and for some distance under the sea.

(c.) Military Objections.

23. The year 1880 marks an important stage in the history of the scheme, as it was in that year that British military objections were first raised. In view of these objections, it was decided, in April 1883, to appoint a Joint Select Committee of both Houses of Parliament "to inquire whether it is expedient that Parliamentary sanction should be given to a Submarine Communication between England and France; and to consider whether any or what conditions should be imposed by Parliament in the event of such communication being sanctioned." The Committee were unable to reach sufficient agreement even to submit a report of their investigations, and, finally, by a majority of six to four, contented themselves with a bare expression of the opinion that it was not expedient that Parliamentary sanction should be given to the proposed scheme. A draft report, setting out in detail the views of Lord Lansdowne, the Chairman of this Committee, who was in favour of the tunnel, summarises the case as it then stood.

24. In view of the opinion expressed by the Select Committee, the scheme was temporarily dropped, but, within the next twelve years, it was brought forward again in Parliament no less than eleven times, but on each occasion without success owing to the objections on military grounds maintained by successive Governments. It was not until after an interval of twelve years that the matter was again raised in Parliament in 1906–07, with the same result. Subsequent attempts in 1914 and 1919–20 to reopen the

question were also unsuccessful, the Government of the day in each case resting its objections on military grounds. The proposal was again brought forward in 1924 and was referred to the Committee of Imperial Defence. On this occasion the Committee had before them not only the views of the General Staffs of the three services on the defence questions raised by the scheme but also memoranda on its financial, commercial and transport aspects. The latter were prepared in the light of such information as was available by the Board of Trade and the Ministry of Transport. On July 24th, 1924, a statement was made on behalf of the Government in the House of Commons that the Committee of Imperial Defence concluded that the advantages of a Channel Tunnel were not commensurate with its disadvantages from the defence point of view and recommended that the scheme should not be allowed to proceed. This view was accepted by His Majesty's Government. Renewed efforts on behalf of the Tunnel were made in 1928, and these resulted in the appointment in April 1929 of the present Committee.

III.—PROPOSED NEW METHODS OF CROSS-CHANNEL COMMUNICATION OTHER THAN A CHANNEL TUNNEL.

25. The various schemes put before us for the improvement of cross-Channel communications otherwise than by the construction of a railway tunnel under the Channel may be summarised under the following heads :—

(*a.*) The introduction of a cross-Channel passenger and goods train ferry.

(*b.*) The construction of a Tunnel under the Channel that should be open to road traffic as well as to railway traffic.

(*c.*) The construction of a combined railway and road cross-Channel bridge.

(*d.*) The construction of a railway tube to be laid across the bed of the sea between England and France.

(*e.*) The construction of a cross-Channel Jetty.

26. We propose in the following paragraphs to give briefly our conclusions in regard to each of these schemes.

(a.) Channel Ferry.

(i.) *Advantages Claimed.*

27. Those who advocate the introduction of a system of cross-Channel passenger train ferries make a two-fold claim. They urge that a ferry would offer many, and those the most substantial, of the advantages claimed for a Channel Tunnel; and further, that from some points of view a ferry is definitely preferable to a Tunnel.

28. In the first place it is claimed that as regards passenger traffic a ferry would be substantially as attractive as a Tunnel.

Passengers would be able to enter their train at London and would be under no necessity of leaving it until they arrived at Paris or whatever might be their Continental destination. A large part of the delays consequent on embarking and disembarking on the cross-Channel boats would be eliminated; and the length of time occupied by the journey to London could be still further reduced by arrangements being made for customs and passport examinations to be carried out either on the ferry or on the train. In present conditions movement due to bad weather acts as a material deterrent to cross-Channel passenger traffic. The advocates of a passenger ferry admit that this disadvantage would not be so completely eliminated by a Ferry as by a Tunnel, but they claim that the relatively large size of ferry boats would greatly reduce the amount of discomfort experienced in present conditions in bad weather and would secure for a ferry system as large or almost as large an increase in passenger traffic as it is anticipated would follow the construction of a Tunnel. As regards goods, a ferry would, according to this view, be fully as good as a Tunnel, as it would offer the same advantages, viz., avoidance of transhipment, more rapid delivery, and, in the case of perishable goods, delivery in better condition than at present.

29. The second advantage claimed for a ferry is that its initial cost would be very small compared with that of a Tunnel. In its early days the service would be largely experimental, but, if in fact, it secured the traffic anticipated for it, there would be no difficulty in increasing the number of ferry boats on the service. On the other hand, the amount of traffic that a Tunnel would carry is definitely limited and the whole of the contemplated expenditure has to be incurred before it can be opened to traffic. Further, if circumstances were favourable, ferry services could be instituted between a number of British and Continental ports, there being no necessity as in the case of a Tunnel to concentrate the whole traffic on a single route. Finally, the advocates of a ferry point to the uncertainty whether it is actually possible to construct a Tunnel and to the large sums of capital which would be wasted if, at a late stage of the work, difficulties arose which made it necessary to abandon it.

(ii.) *Disadvantages of Train Ferries.*

30. It appears from the evidence laid before us that Dover is the only English port at all suitable for such a service, as Folkestone could only be made available at a heavy expense. On the French coast, Calais, which was used during the war, would probably be the most suitable port, though Boulogne could also be used.

31. If a train ferry service were established, it would clearly be desirable to employ boats of considerable dimensions in order to reduce movement due to bad weather to a minimum. Sufficient depth of water is, we are informed, available at Dover for a boat with a draught of 16–18 feet, *i.e.*, with a length of from

750–850 feet, equipped with four railway tracks, each capable of taking one complete train. It appears, however, that at the Continental ports, the depth of water available is only sufficient to take boats with a draught of 13–14 feet, and that it could only be increased at very heavy cost. A ferry boat of this shallow draught would be unmanageable in these ports if built of the length suggested above. It would, however, be possible to construct an efficient ferry boat with a length of about 400–500 feet with four tracks on the deck, platforms between the tracks and cabins for the passengers. But a boat of this size would be open to the objection that full length trains using the ferry would have to be split in half with a consequent delay in loading and unloading. In addition, a relatively small boat of this type would be much less satisfactory for use on a passenger service in rough weather.

32. At the ports under consideration, the difference between high and low water is considerable. According to Admiralty tide tables, that between mean high water spring tide and mean low water spring tide is 18 feet at Dover and 21 feet at Calais. Various methods have been adopted and suggested for transferring trains to and from ferry boats. One method is to have a platform with, say, two railway tracks on it, which can be raised or lowered to the level of the ferry boat deck, trains being run on to this platform, which is then raised or lowered to the level of the railway tracks on the shore. This method, we are advised, is feasible and safe, but the cost of construction is high. Another method would be to have an enclosed dock in which the water level would be so adjusted that the railway tracks on board and ashore coincide. This method can only be adopted in favourable conditions, which, according to our information, do not exist in the harbours under consideration. A third and commonest method is to have a steel transfer bridge, hinged at the edge of the wharf, and supported near its outer end by a pontoon in such a way that it can be raised or lowered by the tide to suit the level of the boat. The construction of a transfer bridge of this type would not, we are advised, present any great engineering difficulties, but, in order that the gradient on it should at no point exceed 1 in 20, it would have to be made of greater length than is usual, and would occupy a long stretch of the port or quay.

33. There seems little doubt that a ferry such as that described above would be feasible. Dover harbour is not, however, well adapted for train ferry work, and unless the ferry boat berthing dock were placed in the submarine basin, it is probable that, with the wind in certain quarters, the movement would be sufficient to prevent loading and unloading. To ensure a regular and dependable service, it would, therefore, be necessary to undertake additional protection work inside the harbour, which would considerably raise the cost of this terminus. The berthing dock could, however, be placed in the submarine basin at a less cost, if the necessary railway connections were made.

34. The following is the closest estimate that we have been able to obtain of the probable cost of a passenger and goods ferry. It should, however, be definitely regarded as approximate only :—

	£
Cost of Terminus at Dover, say ...	672,000
Cost of Terminus at Calais, say ...	305,000
4 boats at (say) £250,000 ...	1,000,000
	1,977,000
Add 10 per cent. ...	197,000
	2,174,000

35. If it were considered desirable to use Boulogne as well as Calais, an additional outlay of approximately £410,000 would, we are advised, be necessary. A saving of approximately £200,000 on the above figures might be secured if it was found possible to use the submarine basin at Dover. The evidence laid before us suggests that the cost of a ferry would probably be reduced by half if it were confined to goods and motor vehicles. A ferry service confined to goods would not, however, constitute an alternative to a Channel Tunnel, as the chief merit claimed for a Tunnel lies in the anticipated increase of cross-Channel passenger traffic.

(iii.) *Conclusion.*

36. Even if the additional works referred to in the preceding paragraphs were carried out, the cost of instituting a cross-Channel passenger ferry service would be much less than that of building a Channel Tunnel. We are, however, satisfied that the Dover–Calais and Folkestone–Boulogne routes are unsuitable for a passenger ferry service. We base this view mainly on the following considerations :—

(*a.*) For these routes it would be necessary to employ boats of shallow draught and therefore of relatively small size. From the point of view of passengers who object to a sea passage in rough weather, such a ferry would offer few, if any, advantages over the existing Channel boats.

(*b.*) The relatively small size of the ferry boats would make it necessary to split the trains. There would therefore be little or no saving of time in the cross-Channel journey by train ferry as compared with the existing services.

37. Further, it should be observed that the war-time Channel Ferry services, to which reference has been made, were goods services. The operation of a goods ferry in the circumstances then obtaining was comparatively simple. There was no necessity for time-tables to be strictly adhered to, and it was thus possible to take advantage of favourable weather and tides. Such methods of working would, however, be out of the question for a commercial passenger and goods service in time of peace. In the

circumstances we are satisfied that though a passenger train ferry service could be instituted, it would offer few attractions as compared with the existing boat service. We have reason to believe that this is also the view of the Railway Companies concerned, who, in existing conditions, are free to institute such a service, and would no doubt have done so if they had thought it commercially attractive.

(b.) Combined Railway and Road Tunnel.

38. No actual proposals have been submitted to us for a combined rail and road tunnel, but, in reply to an inquiry regarding their views on the economic aspects of the proposals for a tunnel, one of the Trade Associations expressed the opinion "that if it should be decided by His Majesty's Government to proceed with the construction of such a Channel Tunnel, the Tunnel should embrace a scheme for the transport of goods and passengers by road." At first sight such a proposal is not without its attractions, but, apart from the very heavy increase which its adoption would entail in the cost of the scheme, we are satisfied on investigation that for other reasons it is impracticable. Any tunnel constructed under the Channel would of necessity be about 36 miles long and would be constructed in the form of an inverted syphon, the lowest part of which would be some 300 to 400 feet lower than either end. The carbon monoxide gas given off by motor cars from their exhausts is fatal to human life. If motor traffic was permitted in the tunnel, the gas given off, being heavier than air, would accumulate in the lower levels of the tunnel. We are advised that it is extremely doubtful whether any form of blower or suction fan could be constructed of sufficient power to drive such gas from a tunnel 36 miles long. Unless arrangements to this end could be made, it would be impossible for cars to be driven through the tunnel. We understand that, even in the short-length tunnels under the Thames, difficulty is experienced with the gas from motor car exhausts, and that drivers not infrequently suffer from gas poisoning when blocks occur in the traffic in these tunnels. This is particularly significant if regard is had to the fact that, compared with a Channel Tunnel, the Thames Tunnels have very little depth and are of considerably greater diameter than any tunnel proposed to be constructed under the Channel.

(c.) Channel Bridge.

39. At a late stage of our inquiry we received from Sir M. MacDonald & Partners and Monsieur A. Huguenin, Managing Director of the Société Technique d'Études et d'Entreprises pour l'Industrie, particulars (including plans and sections) of a scheme for a Channel Bridge. The design submitted contemplates the construction of a bridge between Folkestone and Cape Grisnez, a distance of 22 miles. For the greater part of its length the bridge

would carry two railway tracks, but on a length of 3 miles situated about midway across the Channel it is proposed to construct a Passing Station of four lines of tracks. This would allow for a large increase of traffic over that which could be carried by a continuous two-line track. Above the railway tracks it is proposed that there should be a roadway 33 feet wide which would be sufficient to carry four lines of traffic. To meet the requirements of navigation, the bridge as designed provides a clearance of 200 feet above high water level for a length of 10,000 feet (*i.e.*, five spans of 2,000 feet) on each side of the two routes 4 or 5 miles away from the French and English coasts respectively, which the designers state are principally used for navigation up and down the Channel. Ample and powerful lighting for the piers in each fairway would also be provided. The authors of this scheme claim that a bridge of this design would not cause any serious obstruction to navigation, the spans of 2,000 feet being greater than those of the Forth Bridge and the clearance being larger than that provided in any existing bridge. It appears from the plans of the design submitted that it is proposed that the spans of the bridge should be of the continuous suspension type with inverted three hinged trusses and cable wind trusses. There would be twenty-six spans on the British side and twenty-seven on the French side, each 2,000 feet in length, and a four track bridge of twenty-nine spans of 450 feet each in the centre of the Channel. The authors of this scheme estimate its total cost at £75,000,000. They anticipate that the receipts of the Bridge in its first year of operation would be as follows :—

Per Annum.	Rate.	£
2,500,000 Railway passengers ...	£1	2,500,000
1,000,000 Road passengers in private cars and buses	£1	1,000,000
10,000,000 tons rail freight	10/-	5,000,000
1,000,000 tons lorry freight	10/-	500,000
		9,000,000

This income would, in their view, cover the cost of operation and upkeep, and in addition would provide an adequate return on the capital expended. They propose that the Bridge should be owned by a British public company, which should also have full power of control over the road traffic, the rail traffic being under the control of the Southern Railway. They further propose that the connecting railway from Cape Grisnez station and the connecting road at the French end of the Bridge should be constructed by French companies.

40. It is clear from the data placed at our disposal that a great deal of thought has been given to the engineering problems that would be involved in the construction of the proposed bridge. We are not in a position to question the feasibility of such a project from the engineering point of view, vouched for as it is by so eminent authorities as Sir Murdoch Macdonald and Monsieur Huguenin.

We think it right to point out, however, that the design and construction of such a bridge would involve many problems for the solution of which there is no exact precedent, and that it would require a considerable amount of preliminary investigation and examination before the nature of the difficulties likely to be encountered could be properly estimated. Further, the problems connected with maintenance, involving the remedying and forestalling of damage to which the structure both above and below water would be liable, present difficulties which in the light of present knowledge would seem to render any estimate of cost of maintenance and upkeep extremely unreliable. We have not, however, thought it necessary to pursue a technical examination of the scheme as we are convinced that on other grounds it cannot to-day be considered a practicable solution of the problem of cross-Channel communication. As regards the financial aspect of the proposal, the estimated cost of the scheme is, in our view, prohibitive. Further, we do not think that at the relatively high rates proposed the bridge would be likely to secure the volume of either rail or road traffic indicated above. The gravest objection to the scheme is, however, the obstruction which such a bridge would cause to navigation and the difficulty, amounting in our view to an impossibility, of securing agreement for its construction. As regards the lighting of the bridge, we understand that there are at present no satisfactory or reliable lights capable of penetrating fog for any considerable distance and that powerful foghorns are not always reliable owing to atmospheric conditions and silent zones. We are advised that, even if it were possible adequately to light the piers, navigation in the Channel during foggy weather would be exceptionally difficult and that even a slight miscalculation would entail disaster, especially for vessels travelling with the tide. Sailing ship traffic, in addition, would become practically impossible, in other than very fine weather, except at considerable towage cost to the owners. In narrow waters such as the Channel having peculiar tidal effects subjected to a fair amount of mist and fog, the difficulties of navigation are always the cause of some anxiety. These difficulties would be very greatly increased by the addition of twenty-six obstructions in the form of piers from the bridge in the British half of the Channel and twenty-seven similar obstructions on the French half. In so far as the piers would be sunk within the 3-mile limit, it might be possible to obtain the necessary approval of His Majesty's Government and of the French Government respectively. For the remainder of the distance the piers would, however, have to be sunk in the bed of the high seas. These piers would undoubtedly cause a serious obstruction to navigation, and we find it difficult to believe that the necessary international agreement for their erection could be secured.

(d.) Rail Tube on Bed of Channel.

41. Another scheme, submitted to us from an Italian source, contemplates the construction of a submerged railway tube on the

bed of the Channel. From the patent specifications placed before us, it appears that the proposed submerged tunnel would comprise a number of tubular elements resiliently connected to one another in regular succession and adapted to be sunk and secured in the desired position on the bottom of the sea. These would be joined to one auother above water in relatively short lengths and would consist of an inner cylindrical sheet metal tube of such thickness of wall as would enable it to withstand the pressure of the water above. The metal tube would be surrounded by a hard compact jacket of concrete or similar material and would be enclosed on the outside by another cylindrical sheet metal tube for the protection and reinforcement of the concrete jacket. Each tubular element would be provided with reinforcing radially arranged longitudinal I-irons embedded in the mass of concrete and firmly bolted and secured both to the inner and outer sheet metal cylinders, so that the two cylinders and the jacket of concrete would be united in a single block. In the form placed before us the scheme contemplated the construction on the foregoing lines of a railway tube having a diameter of 10 feet. The inventor claimed that if constructed in the manner described above, it would be rigid, watertight and immobile while on the sea bottom, but would be sufficiently flexible to be capable of being raised at any point to the surface of the sea for repairs when necessary. Another feature of the scheme would be the construction of two towers rising above the surface of the sea which would provide light and ventilation and would also act as passing stations for the single line tubes. According to the inventor's calculations, it would be possible to construct such a tube at a cost of not more than £2,000,000. This scheme has been considered by our technical advisers, who report that whatever may be the merits or possibilities of tubes on the sea bottom as compared with tunnels, the particular scheme outlined above cannot be regarded as practicable. In addition, the proposed towers would form a serious obstruction to navigation, and, as they would be situated on the bed of the high seas, similar difficulties would be experienced in regard to obtaining international approval for their construction to those to which reference has been made (paragraph 40) in regard to the suggested Channel Bridge. An outline of a somewhat similar scheme was submitted to us from an Australian source. This plan contemplated the construction of a tube which, instead of resting on the bed of the sea, would be raised by stays anchored to the sea bed. This scheme, in our opinion, is open to the same objections and is as impracticable as that discussed in the earlier portion of this Section.

(e.) Cross-Channel Jetty.

42. Finally, we have received from a Swiss engineer a project for the construction of a double jetty across the Channel. Under this scheme two parallel dams would be constructed from Deal to Calais, each carrying two railway tracks and a motor road. The water enclosed between the two dams would form a large canal

for ships and barges. By the construction of an additional canal 15 miles in length from Deal to Herne Bay, London would be directly connected with the whole canal system of France and Germany and with the Rhine and the Danube. It is further proposed that the two dams should be connected with the coast by bridges sufficiently high to afford free passage to steamers. The estimated cost of the scheme is £80,000,000. We have not thought it necessary to consider the technical aspects of this proposal as, apart from its cost, the obstruction to navigation which it would cause in the Channel would be even more serious than that in the case of the Channel Bridge (paragraph 40), and would be sufficient to render the scheme wholly impracticable.

IV.—THE PRESENT PROPOSALS FOR A CHANNEL TUNNEL.

(a.) Tunnel System Recommended.

43. Our terms of reference do not direct us to consider any particular proposal for a Channel Tunnel but to advise generally on the economic questions raised by any proposal for such a Tunnel. We have therefore felt that it was our duty to consider on their merits any scheme that might be submitted to us.

44. In fact, only two Tunnel schemes have been laid before us, the first by the Channel Tunnel Company, the second by the London and Paris Railway Promoters, Ltd. The proposals of the latter Company include the acquisition of the rights of the English and French Channel Tunnel Companies, the construction of a Channel Tunnel and the provision of a new railway from London to the English coast and from the French coast to Paris. They propose that a 7-foot gauge should be adopted for this line and they claim that under their scheme it would be possible to run a train from London to Paris in $2\frac{3}{4}$ hours. The Company estimate the cost of the English section of the railway at £58,500,000, that of the French section at approximately £100,000,000, and that of the Tunnel at £30,800,000. This scheme seems to us prohibitive in cost and impracticable in the present state of engineering knowledge and experience, quite apart from the strong opposition which existing interests would certainly raise as soon as any attempt was made to obtain the necessary statutory powers from Parliament.

45. The proposals of the Channel Tunnel Company are on a different footing. As has been shown in the historical summary (paragraph 18), Parliament has conferred certain powers in connection with the proposals for a Channel Tunnel on this Company and on the Southern Railway (as the successors of the South-Eastern Railway Company). The two Companies have always been closely associated, and the Chief Engineer of the Southern Railway is also Chief Engineer to the Channel Tunnel Company. In our subsequent examination of the proposal for a Channel Tunnel we have therefore confined ourselves to the consideration of the scheme

put forward by the Channel Tunnel Company or to possible modifications of it. The Company's proposal contemplates the construction of a Channel Tunnel of a total length of 36 miles, of which 24 miles would be actually under the Straits of Dover. The remaining 12 miles would be approach tunnels on either coast. The Company would itself undertake the construction of the approach Tunnel at the English end and of the English half of the Tunnel under the sea. The other half of the Tunnel under the sea and the French approaches would be built by the *Association française pour l'étude et la réalisation du Chemin de Fer sous-marin entre la France et l'Angleterre.*

46. The Company propose that the tunnelling to be undertaken should consist of (*a*) two independent traffic Tunnels, each with a diameter of 18 feet 6 inches, and (*b*) of a smaller pilot tunnel, having a diameter of 10 feet, for drainage and ventilation purposes. The Company consider that the only practical route for the tunnel would be in the bed of the grey chalk, and that the geological data available (paragraphs 20 to 22) are sufficient to justify an immediate start being made on the pilot tunnel without further extensive geological investigations. The Chemin de Fer du Nord are also optimistic regarding the continuity of the geological formation, but consider that expenditure amounting to, say eight or ten million paper francs would be desirable on further exploratory work before the boring of the pilot tunnel is begun. These preliminary investigations would include the sinking of new borings, the testing of the latest excavating methods, and also an examination of the various means of evacuating the spoil, *e.g.*, by the Fougerolles method (paragraph 60) or otherwise. The Nord Railway state that they are prepared to undertake this expenditure provided that they are assured in advance that objections on military or other grounds will not be raised at a later stage by His Majesty's Government. Both the British and French Companies propose that the pilot tunnel should be driven through the whole length of the under-sea section before any work was undertaken on the main traffic tunnels. The whole of the Tunnel section linking the Southern Railway and the Chemin de Fer du Nord would be electrically operated, and for this purpose it would be necessary to construct exchange stations at each end of the Tunnel. It is anticipated that the open approaches from the mouth of the Tunnel to the exchange station on the English side (which would be at Sandling Junction) would be 3 miles and 20 chains in length and that the length of those on the French side would be 5 miles and 30 chains. The Channel Tunnel Company would not themselves own any rolling-stock. Under the scheme the cost of the exchange stations and of any consequential improvements that might be required in the existing railway lines to the English and French coasts would be met by the Southern Railway and the Chemin de Fer du Nord respectively. The latter Companies would also share the cost of the new steel rolling-stock required. The Channel Tunnel Companies would not themselves maintain or

operate the Tunnel section, but would enter into agreements for these services to be carried out by the Railway Companies named above, which would be in a position to do so at a substantially lower cost.

47. The Company estimate that it would be possible to complete the pilot tunnel in a period of about $2\frac{1}{2}$ years and the traffic tunnels in about $4\frac{1}{2}$ years. The whole operation could, in their view, be carried through in a period of $6\frac{1}{2}$ to 7 years. They estimate the cost of the pilot tunnel at £5,000,000, and that of the traffic tunnels (including approach tunnels) at £25,000,000. Of the total expenditure of £30,000,000, one-half would fall to be met by the English Company. As regards the finance of the scheme, the Company have informed us that, in the first instance, they would propose to confine themselves to an issue of ordinary shares sufficient in amount to cover the cost of the English section of the pilot tunnel. Under this scheme the actual work of construction would be carried out simultaneously by two Companies, the British Company building the British half, and the French Company the French half. The Company realise that the closest co-ordination would be necessary between the work of the two Companies, and suggest that this might be secured by the formation of a single holding Company. The Company do not anticipate any difficulty as regards the maintenance and subsequent operation of the Tunnel. They point out also that by means of the Tunnel it would be possible to maintain continuous services without fear of interruption as at present owing to rough weather. It is true that if a Tunnel was constructed, a larger proportion of the total traffic would be concentrated on a single route than at present. A temporary breakdown in one of the traffic tunnels might therefore lead to considerable congestion, but it should always be possible to maintain a modified service by running trains in either direction in the remaining traffic tunnel.

(b.) The Gauges Proposed.

48. The foregoing estimates by the Channel Tunnel Company assume that so far as the track gauge is concerned British rolling-stock could run on Continental lines and Continental rolling-stock on British lines. The difference between the British and Continental standard track gauges does not amount to more than three-sixteenths of an inch, and from the evidence we have received it is clear that no difficulty on this account would be experienced in the interchange of British and Continental rolling stock. This view is confirmed by the experience gained during the war, and also more recently by that of the London and North-Eastern Railway Company, who, for a number of years past, have successfully operated a train ferry between Harwich and Zeebrugge.

49. There are, however, important differences between the structural loading gauge in this country and that in use on the Continent, where, under the Berne Agreement arrived at in the

early part of this century, vehicles can be employed about 25 per cent. greater in their cross-section area than is possible in this country. Before vehicles conforming to the Berne standard could be employed in England, heavy expenditure would have to be incurred in widening tunnels, re-spacing tracks, strengthening bridges, and otherwise adapting the existing system to their use. It has been estimated that before Continental coaches could be brought from the coast to London, expenditure of upwards of £10,000,000 would require to be incurred by the Southern Railway, an expenditure which might prejudice the success of the scheme from the financial point of view. Up to the time of the present inquiry it has been generally assumed that such alterations would be necessary, and that the Southern Railway would have to look to its share of the profits arising from the tunnel to recoup itself for this outlay. Since our appointment, conversations have, however, taken place between the Southern Railway and the Chemin de Fer du Nord, as a result of which the witnesses who appeared before us on behalf of those Companies were able to state that rolling-stock constructed to suit the English loading-gauge would be accepted in France if a tunnel was built. We understand that this arrangement would be applicable to the whole of the French railways, and that probably arrangements could also be made to permit such vehicles operating on the Swiss and Italian systems. Under such an arrangement, foreign railway companies would construct a given number of vehicles to the English loading gauge for use on the tunnel service. Such rolling-stock would not, to any great extent, be smaller than the ordinary modern Continental coaches, as their height would be only slightly reduced, and their width need not be more than five inches less than that of the most modern coach run in France. As regards existing English coaches, we are advised that the majority could be made without great expense to run on the Continental lines should this, at any time, be advisable.

50. This development very materially reduces the cost of the tunnel scheme, as it relieves the Southern Railway of the necessity of recasting their system from the coast to London. The Southern Railway inform us that in the altered circumstances the only expenditure that they anticipate having to incur in connection with the construction of the Tunnel, apart from any outlay due to increase in traffic, would be (*a*) the provision of the exchange station at Sandling Junction and of about 3½ miles of railway, (*b*) the connecting up of the electrical supply to the "Grid," which they assume would be provided by the Central Electricity Board by 1938, (*c*) the provision of the necessary electric locomotives, (*d*) the provision of additional rolling-stock for through running to the Continent, and (*e*) the provision of additional stabling and cleaning sheds in London for the carriages engaged in this through running. The cost under heading (*a*), which includes the necessary bonded goods warehouses, the locomotive and carriage sidings and sheds, marshalling sidings, customs accommo-

dation, land, &c., is estimated by the company at £2,000,000. As regards items (*b*) to (*e*), the company state that they are not in a position to form reliable estimates of cost until the detailed schemes of the services and through working have been tabulated. They estimate, however, that they would require at least £3,000,000 of new capital to carry out the consequential works ((*a*) to (*e*)) referred to above.

51. As regards waggon stock, the position is substantially the same as that for passenger rolling-stock, most Continental waggons being unable to run on British railways. There are, however, a certain number of waggons on the Continent which, with a few small alterations, could be made available for the tunnel service. We understand from the evidence submitted to us by the Chemin de Fer du Nord that they contemplate that special waggons should be built by the British and Continental railways for the tunnel service, and that wherever, say in France, sufficient goods traffic to England was attracted to the tunnel route, such waggons would be employed. In that case there would be no need for transhipment at French ports. In the case of less localised goods traffic, or traffic coming from greater distances, transhipment from ordinary Continental waggons to tunnel service waggons would be necessary.

V.—GEOLOGICAL AND ENGINEERING PROBLEMS.

(a.) The Feasibility of a Channel Tunnel.

52. In the historical survey (paragraphs 20–22) we have given a brief outline of the geological investigations which have been undertaken with a view to ascertaining the practicability of driving a tunnel under the Channel. On this subject we received a detailed memorandum from Sir John Flett, Director of the Geological Survey, which was supplemented by oral evidence from Mr. John Pringle, an officer of that Department, who has made a special study of this subject, who appeared before us on his behalf. Evidence regarding the investigations undertaken by French geologists was submitted to us by Monsieur Javary, Managing Director of the French Channel Tunnel Committee and General Manager of the Chemin de Fer du Nord. In addition, Baron d'Erlanger, the Chairman of the British Channel Tunnel Company, was good enough to obtain permission, for which we are most grateful, from the French Ministry of Public Works for the communication to us of the Report, dated July 1919, prepared by a French Government Channel Tunnel Committee under the Chairmanship of Monsieur C. Colson.

53. The data available fall into three classes, namely, that afforded by the beds of chalk showing on the cliffs on each side of the Channel, by the corresponding beds disclosed by shafts and headings which have been driven on the English and French coasts, and by the soundings in the Channel and surface samples obtained from its bed by the French

geologists in 1875 (paragraph 21). As regards the general line of the tunnel, the evidence of the geologists is substantially unanimous. All are agreed that if a tunnel is to be constructed, it must be driven on a line below the water-bearing strata of the upper and middle chalk. Equally, they are agreed that it must be on some line above the gault, which overlies the lower greensand which has as much, if not more, water than the upper chalk. It follows, therefore, that, in their opinion, the only formation in which the construction of a tunnel could be attempted with any hope of success is the lower chalk. With their report the Consulting Engineers submitted a plan and section (see Appendix IV) showing the suggested centre line for the Channel Tunnel and the strata which they anticipated would be encountered on that line. From the geological point of view, the success of the undertaking depends on the continuity under the Channel of the lower chalk. The evidence referred to above points generally to the conclusion that it does extend uninterruptedly across the Straits. There is, however, an undoubted risk that fissures or even infilled valleys may be encountered.

54. The whole of the evidence which we have received on this part of the subject has been placed at the disposal of the consulting engineers, who have themselves also undertaken independent inquiries. In their report (Section (1) (*a*) (i) and (ii)) they discuss the possibility of employing cementation in the event of water being encountered in large quantities, and express the view that if fissures, filled with rough gravel and, therefore, affording fairly free passage for the sea water, were met with, cementation would probably seal them up, but that if close sand were met with, which yielded large quantities of water, the conditions would be more difficult, and the success of the process doubtful. They add, however, that, with the development of engineering resources, fissures, unless of exceptional size, would not present any insuperable difficulty. As regards the possibility of meeting an infilled valley charged with water at a pressure of, say, 150 lbs. per square inch, they consider that the position would be very serious, but even in that event they hesitate to say that the project would have to be abandoned, as it might be possible to deal with it by adopting a shield with an entirely closed face, the excavation being removed by powerful water jets and washed through controlled pipes in the bulkhead.

(b.) Preliminary Exploratory Work.

55. The witnesses who have appeared before us have expressed divergent views regarding the need for, or desirability of, further geological investigations before work on the pilot tunnel was actually begun.

56. Some, like the Channel Tunnel Company, feel that the information already obtained is substantially as full as can be looked for and that the only geological investigation that would throw real

light on the feasibility of a Channel Tunnel would be the successful construction of the proposed pilot heading. Others take a contrary view and urge the need for further soundings or even borings through the bed of the sea. Most witnesses expressed the view that it was desirable that surface samples should be obtained at least from the sector about half-way across the Straits from which no samples were obtained in the previous surveys. The Consulting Engineers concur in this view and recommend that samples and soundings should be obtained from this and other areas from which sufficient data are not at present available. As regards the latter, we understand that the proposal is that a sufficient number of samples and soundings should be obtained to afford a rough check of the accuracy of the former surveys. It is stated that the necessary observations if carried out by one of His Majesty's Surveying Ships could be made in the space of one or two months, provided that the weather was good. The Consulting Engineers do not favour borings on the bed of the Channel. They point out that they could not, except at enormous expense, be made at frequent intervals, and that even then there would be no certainty that fissures or infilled valleys did not exist between them. In general, they hold that a definite opinion on the feasibility of constructing a Channel Tunnel cannot be expressed until the ground has been proved by the construction of a pilot tunnel.

(c.) Pilot and Drainage Tunnels.

57. The scheme put forward by the Channel Tunnel Company (paragraph 46) contemplates the driving of a pilot tunnel with an internal diameter of 10 feet for the whole width of the Straits before any expenditure is incurred in connection with the main traffic tunnels. The intention is that this tunnel should be so sited that it would rise towards the centre of the Channel, and thus, being below the main tunnels, would be available for drainage purposes. In such a drainage tunnel, any water encountered would flow by gravitation to the pumps at the shore ends.

58. All the witnesses that have appeared before us agree on the necessity of a pilot tunnel. They differ, however, in their conception of the functions and siting of such a tunnel. Some favour the plan of the Channel Tunnel Company and consider that the pilot tunnel should be so constructed that it should be available afterwards for drainage purposes. Other witnesses point out that a pilot tunnel of this kind would be open to the objection that, owing to the north-easterly dip in the geological formation of the Channel, it would emerge at the English coast some three miles or more to the east of the proposed alignment of the main traffic tunnels. A pilot tunnel so constructed could therefore give no indication of the continuity of the lower chalk along a considerable section of the route proposed for the traffic tunnels. The witnesses who hold this view recommend that to get over this difficulty the pilot tunnel should be driven on substantially the same line and at

the same general level as the proposed traffic tunnels, and that, in order to check the formation through which the latter would actually pass, radial boreholes should be driven at regular distances. Some witnesses who adopt this view consider, however, that concurrently with the construction of a pilot tunnel on the line of the proposed traffic tunnel, there should be driven also a drainage tunnel. In their opinion the latter will in any case be required as part of any Channel Tunnel scheme, and the construction of the pilot tunnel would be easier and the risks run by the labour engaged less if the drainage tunnel was constructed concurrently.

59. These views have been carefully examined by the Consulting Engineers, who recommend a slight variation from any of the plans that have been laid before us. They consider that there should be a drainage tunnel having an internal diameter of 7 feet, and that it should slope from the centre of the Channel down to the coast on each side to permit of drainage by gravitation. They agree also that a pilot tunnel should be driven substantially along the line of the proposed traffic tunnels. They recommend that, as the pilot tunnel proceeds, advance and radial boreholes should be driven from it to explore the ground ahead and all round it in order to obtain the fullest information regarding the ground through which the main tunnels would subsequently be driven. The drainage tunnel and the pilot tunnel could, in their view, be driven simultaneously, but the former should be kept in advance. As regards the internal diameter of the pilot tunnel, they consider it should be about 12 feet (instead of 10 feet as proposed by the Channel Tunnel Company), and that, if it is successfully completed, it should become a permanent unit in the Channel Tunnel scheme, and should not be enlarged to form one of the main traffic tunnels. This tunnel (and the drainage tunnel) would be lined throughout, and if constructed with the diameter which they recommend, it would provide sufficient width for the temporary railways which would be required during its construction for the disposal of the spoil and subsequently during the construction of the main tunnels. It would also allow sufficient space for the pipes used for ventilation and other purposes during construction. They recommend that the pilot tunnel should be fitted with the necessary electrical equipment, and, after the construction of the main tunnels, should be used for the conveyance of men and material required for the maintenance of the tunnels and of the permanent way and electrical equipment. From the point where the drainage tunnel approaches the pilot tunnel, they suggest that at fairly frequent intervals connections should be made between the two. They estimate that the pilot and drainage tunnels could be driven in about five years on the assumption that rotary excavators were employed in each case. There is general agreement among witnesses that, on the successful completion of the pilot and drainage tunnels, it should be possible to construct the main traffic tunnels in a considerably shorter time, as work could be carried on simultaneously on a

considerable number of faces. The Consulting Engineers consider that three years should suffice for the construction and equipment of the main traffic tunnels. The whole operation, including the construction of the pilot and drainage tunnels could, therefore, in their view, be carried out in a period of eight years.

(d.) The Disposal of the Spoil.

60. The scheme recommended by the Consulting Engineers contemplates that the spoil would be disposed of by waggons. Various witnesses have, however, suggested that by the addition of water it might be possible to reduce the excavated material to a slurry capable of being pumped out of the tunnel. In his evidence before us, Monsieur Javary strongly urged upon us the desirability of investigating a scheme elaborated by Monsieur Fougerolles for the disposal of the spoil. If the latter's estimates were in fact realised, a very material reduction would be secured in the cost of constructing the tunnel. In view of the importance attached to this question by Monsieur Javary, we decided in drawing up the terms of reference to the Consulting Engineers to invite them to express an opinion on the feasibility of Monsieur Fougerolles' proposals. The Consulting Engineers discussed this plan with representatives of Monsieur Fougerolles, but in their report (Section (1) (*d*) (ii)) they are unable to express any view on it until a trial has been made under conditions similar to those which would obtain in the actual construction of the Channel Tunnel. The scheme contemplates the employment of a rotary tunnelling machine substantially similar to those used on the London underground railways. In practice, it has been found that these machines can excavate so rapidly that the main difficulty has been the disposal of the spoil. The scheme proposes that this difficulty should be overcome by treating the debris with water in such proportions as would reduce it to a slurry that could be pumped out on to the bed of the sea. This would be done by borings to the sea-bed lined with steel tubes. The Consulting Engineers suggest that arrangements might be made for Monsieur Fougerolles to test the efficacy of his scheme in the heading driven under the sea on the French side about the year 1880. In view of the large economies that would be effected if the system could be successfully employed, they recommend that the carrying out of this trial, of which they understand the cost would be about £40,000, should be carefully considered before any decision was taken to dispose of the spoil in the ordinary way by waggons.

(e.) The Cost of the Tunnel.

(i.) *The Cost of Construction.*

61. At our request, the Consulting Engineers have prepared an independent estimate of the cost of a Channel Tunnel. As has been shown in paragraph 59, the scheme which they recommend includes

the construction not only of two independent traffic tunnels with a diameter of 18 feet 6 inches, but also of permanent pilot and drainage tunnels. It consists in effect of a system of four independent tunnels. Such a scheme must necessarily be more costly than any that contemplated only three tunnels, namely, two traffic tunnels and either a drainage or a pilot tunnel. The estimates submitted by the Channel Tunnel Company are therefore not strictly comparable with those prepared by the Consulting Engineers. The Company estimate, for their scheme, an expenditure of £5,000,000 for the pilot tunnel, but in their evidence the Southern Railway express the view that this figure should be increased to £6,000,000, as in their opinion it would be desirable to have two pilot headings. The estimate prepared by the Consulting Engineers for the drainage and pilot tunnels combined is £5,600,000. In considering the estimates of the probable cost of the main traffic tunnels, it is important to define the items which have been included and those which have been excluded. Under the scheme, as we understand it, the cost of providing the English and French exchange stations, the open approaches from the mouth of the tunnel to the exchange stations, the electrical locomotives, the necessary rolling stock, and such electric generating stations and land as may be required will fall to be met respectively by the Southern Railway and the Chemin de Fer du Nord, and will not form charges on the British and French Channel Tunnel Companies. The latter Companies will, however, we understand, be required to provide the funds necessary for the disposal of the excavation by specially designed waggons and for dumping it into the sea. They will also be responsible for the construction of the works, permanent way, electrical equipment and sub-stations, signalling, &c. Finally they will require to find interest during construction on the capital employed. On this basis, the Channel Tunnel Company and the Southern Railway respectively estimate that the cost of the main traffic tunnels (including interest on capital during construction) will amount to £25,000,000 and £24,000,000. The Consulting Engineers' estimate provides for electrical equipment sufficient to enable a 10-minute service if necessary to be run at certain times of the day. On this and the other assumptions indicated above, they calculate that the cost of the two traffic tunnels would be £24,850,000. The total cost of the four tunnels is therefore estimated by the Consulting Engineers at £30,450,000. The difference between this figure and that given by them in No. 6 of their summary of conclusions is accounted for by the fact that in the latter figure they have included an item of £450,000 in respect of the open approaches from each end of the Tunnel to the Exchange Stations which, for the reasons explained above, we have excluded from our calculations.

(ii.) *The Cost of Operation and Maintenance.*

62. Considerable diversity of opinion was expressed by various witnesses regarding the probable cost of the maintenance of the

Tunnel. The Channel Tunnel Company themselves submitted an estimate of £1,000,000 per annum, but they admitted that there was a large element of speculation in this figure. In reaching it, they had made what they regarded as an excessive allowance under each of the several heads of expenditure, and, in addition, had added a large sum for contingencies. They expressed themselves as confident that, in fact, the cost would be substantially less than that figure. The Southern Railway stated that they had great difficulty in putting forward any figure. The most that they felt able to do was to suggest, that for purposes of calculation, the cost of maintenance and operation might be taken as roughly equivalent to 40 per cent. of the gross revenue earned by the Tunnel. They said that assuming that the Tunnel earned £1,626,668, the working expenses on this basis would amount to £650,668 per annum. The Chemin de Fer du Nord submitted for our consideration a series of calculations in which they draw attention to the fact that working expenses fall into two categories, namely, those which depend directly on, and those which are independent of, the volume of traffic. After making deductions for the receipts of restaurant car dues and applying a correction in respect of the English half of the Tunnel on account of the higher cost of living in this country, they reach the conclusion that the total working expenses would amount in round figures to 60,000,000 francs. Their estimate of revenue is 310,000,000 francs, so that, on their calculation, working expenses would amount to not more than 19 per cent. of the gross revenue.

63. The Consulting Engineers express the view (Section (1) (*a*) (i) and (ii)) that no difficulty need be apprehended regarding the maintenance of the Tunnel, which would be lined throughout. In sections where the ground contained water, the joints of the lining would be caulked. Such small leakages as would occur could, in their opinion, be dealt with by the water being led to the drainage tunnel for pumping. Similarly, they do not anticipate any serious difficulty regarding the maintenance of the permanent way. They point out that there is less corrosion of the rails, &c., in a tunnel where the traffic is worked electrically than in the open. The inspection and repair of the tracks would have to be carried out mainly at night, and would require careful organisation for the transport of men and materials. It is for this service that the pilot tunnel (paragraph 59) would be principally used after the opening of the tunnel.

64. As regards the operation of the railway, electric traction and automatic signalling would be adopted. The running of the trains themselves would, in the view of the Consulting Engineers, create sufficient ventilation, which could be regulated by openings into the pilot tunnel. If this proved to be insufficient, it could, they suggest, be supplemented by propeller fans, the pilot tunnel being used to convey air to the running tunnels.

65. The Consulting Engineers have, at our request, specially considered the probable cost of the operation and upkeep of the

Tunnel, and report that on the assumption that the electric locomotives and rolling-stock are owned and maintained by the operating Railway Companies, they are of opinion that the expenditure thereon would not reach a sum of £500,000 per annum. This figure includes the cost of the electricity necessary to maintain a ten-minute service, if necessary, at certain times of the day, but does not include the cost of constructing a generating station on the English side, as they assume that by the date that a Channel Tunnel could be opened the necessary current could be obtained from the national scheme under the Central Electricity Board (the "Grid").

VI.—TRAFFIC PROBLEMS.

(a.) Passenger Traffic.

(i.) *Probable Volume of Boat Traffic at the date of the opening of a Tunnel, and Amount of that Traffic which a Tunnel might be expected to secure.*

66. One of the most difficult of our tasks has been to obtain a reliable estimate of the probable volume of cross-Channel passenger traffic in the year of the opening of a Tunnel, and of the proportion of that traffic which a Tunnel might be expected to secure. In dealing with this part of our subject we have thought it convenient in the first place to set out briefly the estimates which have been placed before us by the Channel Tunnel Company, by the Southern Railway, and by the Chemin de Fer du Nord, and then to state the conclusions which we have ourselves reached.

(a.) *Estimate by the Channel Tunnel Company.*

67. The following calculation submitted to us by the Channel Tunnel Company is based upon the assumption that the number of cross-Channel passengers, which they estimate at 2,500,000, may be expected to increase at the rate of 5 per cent. simple per annum; that the earliest date upon which a Tunnel could be opened would be January 1936, and that on that date the total number of cross-Channel passengers would exceed the present total of 2,500,000 by 35 per cent., *i.e.*, 875,000. On this basis, the total number of passengers in that year would be 3,375,000. The Company assume that of this total the Tunnel would secure 80 per cent. of the passenger traffic using the harbours of Folkestone and Dover, *i.e.*, 80 per cent. of 1,000,000=800,000. They further assume that 80 per cent. of the normal increase in the number of passengers using those harbours would use the Tunnel, *i.e.*, 80 per cent. of 35 per cent. of 1,000,000=280,000 passengers. As regards the 1,500,000 passengers at present using other routes,

the Company assume a diversion to the Tunnel of 40 per cent., *i.e.*, 600,000 passengers. They further assume that 40 per cent. in the normal increase of this traffic would also be attracted to the Tunnel, *i.e.*, 40 per cent. of 35 per cent. of 1,500,000 passengers = 210,000 passengers. In addition to the foregoing traffics, the Company assume that the effect of a Tunnel would be to raise the number of foreigners crossing the Channel to that of British subjects so doing, and that the whole of this increased traffic would be carried by the Tunnel. At present, three British subjects to one foreigner cross the Channel, and, on this proportion, out of the estimated 3,375,000 passengers in 1936, 2,531,250 would be British subjects and 843,750 would be foreigners. If the Company's assumption is correct, the latter figure would be increased by 1,687,500. The conclusions of the Company may therefore be summarised as follows:—

80 per cent. of the 1,000,000 passengers using the harbours of Folkestone and Dover (*i.e.*, 4/5ths of 1,000,000)	=	800,000
80 per cent. of the estimated increase in seven years in this traffic (*i.e.*, 4/5ths of 35 per cent. of 1,000,000)	=	280,000
40 per cent. of passenger traffic carried by other routes (*i.e.*, 2/5ths of 1,500,000)	=	600,000
40 per cent. of the estimated increase in seven years of this traffic (*i.e.*, 40 per cent. of 35 per cent. of 1,500,000)	=	210,000
		1,890,000
Estimated increase in number of foreigners who would use the Tunnel		1,687,500
Total in 1936		3,577,500

(b.) *Estimate by the Southern Railway.*

68. The Southern Railway place the number of fare-paying passengers embarking and disembarking by the various Continental routes in 1928 at 2,345,864. Of this they estimate the number carried between Folkestone and Boulogne and Dover and Calais in that year at 1,043,727. On this basis the Southern Railway have furnished us with the following table showing the number of passengers that they anticipate might be attracted to a Tunnel in its first year of working if that year was 1936. It will be observed that the Company assume a normal increase in the number of passengers of 192,745 for the period 1928 to 1936. This increase corresponds to an annual progression of 2·3 per cent. compound. In considering the possible traffics that would be diverted from other routes, the percentages given are based upon the present volume of those traffics without any allowance for increase between the present time and the opening of a Tunnel. This table further assumes that the steamboat services that now run between Dover and Calais and Folkestone and Boulogne would have to be entirely abandoned for the reason that, though a certain number of passengers would still wish to make use of the sea passage, the

number would be insufficient to enable the boat services to be continued, except at a serious loss.

		Number of passengers.	Number of passengers.
Number of fare-paying passengers conveyed by the Southern Railway Company's boats between Folkestone–Boulogne and Dover–Calais during the year 1928		833,727	
Add estimated number of passengers conveyed by the French company's boats between Dover and Calais during the year 1928 (S.A.G.A.) ...		210,000	
		1,043,727	
Deduct number of passengers booked locally between English and French ports (Boat Excursions)		80,000	
			963,727
Add 20% to the 963,727 passengers which it is estimated will represent the normal increase of traffic during the period between the year 1928 and the opening of the Tunnel*		192,745	
Add 15% to the 1,156,472 passengers, being the estimated additional traffic which it is considered may be attracted by the facilities created by the building of the Tunnel		173,471	
Add estimated traffic diverted from viâ Dieppe and other routes, the numbers being as under:—			
Viâ Newhaven–Dieppe	60,000 being 23% of the traffic by this route.		
„ Southampton–Havre	20,000 being 30% of the traffic by this route.		
„ Dover–Ostend	40,000 being 10% of the traffic by this route.		
„ Tilbury–Dunkirk	25,000 being 32% of the traffic by this route.		
„ Harwich–Hook of Holland „ Harwich–Flushing „ Harwich–Antwerp „ Harwich–Zeebrugge	50,000 being 16% of the traffic by this route.		
		195,000	
			561,216
Total in 1936			1,524,943

* Note.—These calculations assume that the tunnel would be available for traffic in 1936.

(c.) *Estimate by the Chemin de Fer du Nord.*

69. The Chemin de Fer du Nord have adopted the following principles in estimating the volume of passenger traffic likely to be secured by the Tunnel. An examination of the passenger traffic from 1894 to 1913 between England and the Continent between the Ports of the Channel and North Sea combined shows a uniform average rate of increase throughout the whole period. The Company have submitted in support of this view a graph (see Appendix V) showing on a logarithmic scale the annual number of passengers during that period and the

mean rate of increase.* They have assumed that each of the mean points corresponds to the number of passengers of the previous year increased by a constant co-efficient. On this view the curve may be regarded as that represented by a capital sum of money put out at compound interest, the rate of interest being the co-efficient of increase allowed for the number of passengers. On this hypothesis the logarithms of the ordinates of the curve fall on a straight line whose gradient will be the co-efficient in question.

70. The Company claim that they have verified this hypothesis and that the broken line of logarithms has, in fact, as an actual trace a straight line whose gradient is 4·11 per cent. They further claim that though the co-efficient is not the same, the same principle has been found to govern the growth of the total traffic of the Nord system and of the total traffic of the combined railways of France. In his evidence before us, Monsieur Javary, the General Manager of the Nord, expressed his conviction that this empirical law of the increase of railway traffic corresponded to a law of nature.

71. The Company assume that the 1st January, 1940, is the earliest date on which a Tunnel could be opened, and, applying their co-efficient of 4·11 per cent., they conclude that by that time the annual number of passengers passing between England and the Continent will be 3,721,000. Of this total, they assume that the following will be absorbed by the Tunnel:—

The whole of the traffic by the following routes across the Channel:

Boulogne–Folkestone.
Calais–Dover.
Dunkirk–Tilbury.

75 per cent. of the traffic of the routes nearest to these, *i.e.*:

Dieppe–Newhaven.
Ostend–Dover.

50 per cent. of the traffic of the routes a little further distant, *i.e.*:

Le Havre–Southampton.
Antwerp–Harwich.

And from 30 per cent. to 35 per cent. of the traffic on the other routes.

* On a "logarithmic" scale equal proportional changes are represented by equal vertical distances in all parts of the vertical scale, so that, *inter alia*, factors increasing at a constant compound rate are represented by straight lines, which are easier to interpret than the curved lines which would result from using an "absolute" scale

72. As regards the additional passenger cross-Channel traffic directly due to the existence of a Tunnel, the Chemin de Fer du Nord consider that the co-efficient of 4·11 per cent., which they anticipate until the opening of a Tunnel, can safely be doubled (*i.e.*, raised to 8·22 per cent.) for the first five years after its opening as a result of the powerful stimulus (*coup de fouet*) which a Tunnel would give to traffic. The Company are convinced that this co-efficient is by no means exaggerated, since the rate of progression actually rose to 9·6 per cent. during the years 1920–24. The Chemin de Fer du Nord therefore estimate that the number of passengers who may be expected to use the Tunnel would amount to 3,200,000 in 1940, which they assume would be the first year of its operation.

(d.) *Conclusions.*

73. The success of a Channel Tunnel is so largely dependent on the volume of the traffic that it attracts that, in addition to giving the views of the principal witnesses (paragraphs 67 to 72) that have appeared before us, we have thought it desirable ourselves to undertake an independent investigation of this question. It is clear from evidence before us that there has been a regular increase in the number of passengers year by year on the bulk of the Channel services. This may be regarded as a normal development, following on the increase of population and the growth of national and international trade. For the purpose of this study, we have adopted the following classification of the facilities for Channel crossing provided by the railway companies :—

(i.) Short sea daylight crossing by the two routes, Dover–Calais and Folkestone–Boulogne, together carrying nearly 50 per cent. of the total Channel passenger traffic.
(ii.) Dover–Ostend crossing, which carries the bulk of the Belgian and Central European traffic.
(iii.) Newhaven–Dieppe and Tilbury–Dunkirk crossings, which are popular and cheap crossings carrying tourist traffic.
(iv.) Night services, to Havre, St. Malo and Caen from Southampton, and several from Harwich for the North European traffic.

Short Sea Route.

74. The total passenger movement on this route since 1850, including boat-excursionists and holders of free passes, has been as follows :—

(Units of 1,000.)

	1850–59.	1860–69.	1870–79.	1880–89.	1890–99.	1909–09.	1910–13 1924–28*
	136	173	182	345	354	491	723
	204	189	178	361	348	415	755
	143	292	269	367	335	439	790
	161	239	286	372	309	498	846
	160	244	305	307	326	532	971
	215	252	316	307	355	578	1,035
	178	234	310	363	336	631	1,068
	169	346	312	362	378	652	1,054
	140	248	404	366	404	697	1,109
	148	271	304	461	431	675	...
Total per decade ...	1,654	2,488	2,866	3,611	3,576	5,608	8,351
Average per annum ...	165	249	287	361	358	561	928
Compound rate per annum increase per decade...	...	4·2%	1·5%	2·3%	...	4·6%	5·7%

The increase from an average of 165,000 per annum in the first decade to 928,000 per annum in the last period represents an average increase over fifty-nine years of 3·8 per cent. per annum compound.

* The war years destroyed the normal progression of civilian channel traffic and it was not until 1924 that traffic of pre-war dimensions was re-established so that the years 1914–23 are omitted from these statistics.

Dover–Ostend Route.

75. The passenger movement on this route (including that of holders of free-passes) since 1860 has been as follows :—

(Units of 1,000.)

	1860–69.	1870–79.	1880–89.	1890–99.	1900–09.	1910–13 1924–28.
	5	37	27	75	110	222
	5	68	24	82	123	182
	18	50	27	87	122	191
	14	40	28	96	119	154
	16	40	35	118	122	189
	16	37	31	115	136	299
	12	34	33	119	145	309
	13	28	42	124	154	370
	14	26	56	117	156	411
	18	25	54	117	160	...
Total per decade	131	385	357	1,050	1,347	2,427
Average per annum ...	13	38	36	105	135	270
Compound rate per annum increase per decade	...	11·3%	0·5%	11·3%	2·6%	8·0%

The increase from an average of 13,000 in the first decade to 270,000 in the last period represents an average increase over forty-nine years of 6·5 per cent. per annum compound.

Newhaven–Dieppe Route.

76. The passenger movement on this route (including that of holders of free-passes) since 1850 has been as follows:—

(Units of 1,000.)

	1850–59.	1860–69.	1870–79.	1880–89.	1890–99.	1900–09.	1910–13 1924–28.
	2	37	36	73	97	270	199
	26	42	48	78	105	182	211
	13	54	47	80	104	195	214
	16	39	53	82	112	202	233
	19	46	56	71	133	213	274
	39	44	60	68	150	217	295
	35	38	59	80	165	224	302
	39	87	58	78	164	220	310*
	...	41	147	89	167	241	338*
	36	51	65	183	176	215	...
Total per decade ...	225	479	629	882	1,373	2,179	2,376
Average per annum ...	22	48	63	88	137	218	264
Compound rate per annum increase per decade...	...	8·1%	2·7%	3·4%	4·6%	4·8%	2·1%

The increase from an average of 22,000 per annum in the first decade to 264,000 per annum in the last period represents an average increase over fifty-nine years of 4·3 per cent. per annum compound.

Night Services.

77. The various night services do not show such a definite progression, except, perhaps, the Hook service.

* These figures include passengers using the Tilbury–Dunkirk night service, which has been recently introduced. This service is in direct competition with the Newhaven–Dieppe cheap night service, and for the purpose of these figures has been added to the service from which the traffic has been principally diverted.

Total Traffic by all Routes.

78. The passenger movement by all routes since 1850 (including that of holders of free-passes and that of day excursionists on the short sea routes) has been as follows :—

(Units of 1,000.)

	1850–59.	1860–69.	1870–79.	1880–89.	1890–99.	1900–09.	1910–13. 1924–28.
	138	215	271	519	654	1,092	1,528
	229	249	307	543	674	953	1,572
	156	379	381	557	657	1,006	1,649
	177	307	396	567	653	1,086	1,829
	180	321	418	498	743	1,172	1,947
	254	328	434	487	808	1,271	2,053
	213	300	431	557	837	1,365	2,111
	203	468	440	568	869	1,399	2,186
	140	321	636	594	901	1,434	2,346
	184	357	458	788	951	1,426	...
Total per decade ...	1,874	3,245	4,172	5,878	7,747	12,204	17,216
Average per annum ...	187	324	417	588	775	1,220	1,913
Compound rate per annum increase per decade...	...	5·6%	2·6%	3·5%	2·8%	4·6%	5·1%

We have so far measured the progression of passenger traffic by comparing the traffic of one decade with that of the succeeding one. The diagram given in Appendix VI has been constructed from the figures given in the preceding tables on a logarithmic scale and shows the traffic year by year, together with a trend line representing the average progression over the periods indicated. This diagram presents a more comprehensive and reliable picture of the progression of the past. It shows that the progression of the short sea service was at the annual rate of 3·7 per cent. compound for the period 1850–73, that for the period 1873 to 1896 the progression fell to 0·35 per cent. per annum, that thereafter, until 1913, the progression averaged 5·45 per cent. per annum, and that this rate was re-established in the period from 1924 to 1928. In the case of the passengers carried by all cross-channel routes, the compound rate of progression registered for the period 1850 to 1873 was 4·7 per cent. per annum. During the period 1873–98 there was a slowing down in the rate of progression to an average of 3·2 per cent. per annum, but from 1898 to 1913 the rate increased to an average of 4·45 per cent. per annum, which rate has been repeated in the period 1924–28. The average for all services during the whole period under review of 1850 to 1928 (excluding the period 1914–23, being

the years affected by the war) shows a progression of 4·0 per cent. per annum compound.

Traffic in 1938.

79. It will be observed that the average compound rate of increase over the whole period (1850–1928) is lower in nearly every instance than the comparative figures for the last two periods. It may well be that the latter rate of increase will be maintained for part at least of the next ten years. For the purpose of our calculation we have, however, thought it prudent to adopt the least favourable view of the probable growth of Channel traffic. We have therefore calculated the probable volume of passenger traffic in 1938 by taking the actual figures for 1928 and increasing them at 4 per cent. per annum compound. We think, however, that it is not unreasonable to assume that the actual progression will probably prove to be higher. The figures which we give for the 1928 traffic were furnished to us by the Southern Railway, and with the exception of those for the short sea routes include all passengers carried in that year. Of the 1,109,000 passengers carried on the short sea routes, 80,000 were passengers booked locally between English and French ports for day excursions. For the present purpose, these excursionists should, in our view, be deducted from the total number of passengers using these routes. We accordingly estimate that traffic at 1,029,000. The figures for all routes also include persons holding free passes, *e.g.*, railway officials and officers of the customs and police services.

On the foregoing basis the number of passengers to be expected is as follows :—

Route.	1928.	1938.
	Actual.	Progression taken at 4 per cent. per annum Compound.
Short sea, excluding local excursions ...	1,029,000	1,523,000
Dover–Ostend	411,000	608,000
Newhaven–Dieppe	259,000	383,000
Harwich–Hook	169,000	250,000
Tilbury–Dunkirk	79,000	117,000
Southampton–St. Malo and Caen	71,000	105,000
Southampton–Havre	65,000	97,000
Harwich–Flushing	64,000	94,000
Harwich–Antwerp	64,000	94,000
Harwich–Zeebrugge	28,000	41,000
Gravesend–Rotterdam	27,000	40,000
Total	2,266,000	3,352,000

80. The foregoing table shows that the number of persons crossing the Channel annually by all routes may be expected to

increase from the figure of 2,266,000 in 1928 to 3,352,000 in 1928, unless some wholly unanticipated factor causes a slowing down of the usual rate of progression during that period. We have selected the year 1938 for this comparison, as in our view it may be assumed that this is the earliest possible date on which a Channel Tunnel could be opened for traffic.

81. It remains for us to consider to what extent the probable passenger traffic in 1938 would be diverted from existing routes to the Tunnel route. The *Dover–Calais and Folkestone–Boulogne* routes are in a special position, as they would be directly superseded by a Channel Tunnel. As regards the other routes it is important, in considering the question of diversion, to bear in mind that a proportion of the traffic consists of persons who select a particular route because their destination is in the immediate neighbourhood of the port of arrival. Clearly, local traffic of this kind is not likely to be diverted to a Tunnel route to the same extent as through traffic to more distant destinations. In our calculations we have therefore made an apportionment as between local and through traffic. On the Southern Railway routes the basis that we have adopted for this purpose is that suggested to us by the Southern Railway Company, except on the *Newhaven–Dieppe* route as regards which the Company were not in a position to submit definite figures. For that route we have assumed that half the traffic is local and half through traffic. For the *Harwich* routes, we have adopted the basis suggested by the London and North-Eastern Railway Company. That Company stated that they anticipate a diversion to the Tunnel of 50 per cent. of the whole of the through traffic on their routes and a diversion of 10 per cent. of the local traffic, other than that to Holland, from which they do not anticipate any diversion. We consider that this basis may be safely accepted for routes so far distant from the Tunnel as are those operated from *Harwich*. As regards the routes nearer to the Tunnel, we think that the diversion may be put at 75 per cent. of the through traffic and 15 per cent. of the local traffic. In the light of the foregoing considerations, we propose now to examine the extent to which diversion may be expected from each of the existing routes.

Dover–Calais and Folkestone–Boulogne.—On the opening of a Tunnel, a number of travellers would, no doubt, wish to go by sea, but their number would probably not be sufficient to enable even a modified boat service to be maintained except at a heavy loss. In any case, it would probably be to the interest of the Companies concerned to close down the boat service completely with a view to securing the whole of this traffic for the Tunnel. We have therefore assumed a diversion to the Tunnel of 100 per cent. of the passenger traffic on these routes.

Dover–Ostend.—The Southern Railway state that the total number of passengers by this route during 1928 amounted to

411,000, of whom 76,000 (18·5 per cent.) proceeded to Brussels and beyond, so that 335,000 (81·5 per cent.) may be regarded as having booked to local destinations on or around the Belgian coast. We have apportioned local and through traffic on the above basis in calculating the probable diversion from this route. Assuming that the volume of this traffic will increase at 4 per cent. per annum compound till 1938 and that 15 per cent. of the local traffic will be diverted and 75 per cent. of the through traffic, the total diversion that may be anticipated amounts to 158,000 passengers out of a total of 608,000, *i.e.*, 26 per cent. of the whole.

Newhaven–Dieppe.—We have assumed that on this route half is local and half through traffic. On this and the other assumptions adopted for the *Dover–Ostend* route, it may be anticipated that in 1938, 172,000 out of 383,000 passengers would be diverted from this route to the Channel Tunnel, *i.e.*, 45 per cent. of the whole.

Tilbury–Dunkirk.—The London, Midland and Scottish Railway Company assume that the diversion to the Tunnel would be equivalent to the difference between the present number of passengers (79,000 in 1928) and the number of such passengers in 1936. If the traffic progresses at the rate of 4 per cent. per annum compound, it would amount in that year to 117,000. On this basis, the diversion would amount to 32 per cent. of the whole, which is the same percentage as that suggested by the Southern Railway.

Harwich–Hook and Harwich–Flushing.—The London and North-Eastern Railway Company state that in 1928, out of 169,000 passengers carried on the *Harwich–Hook* route, 85,000 can be regarded as local and 84,000 proceeded to Germany and Switzerland. As regards the *Harwich–Flushing* route, the Company state that out of 64,000 passengers, 26,000 were local and 38,000 proceeded to Germany and Switzerland. We accept their view that no diversion to the Tunnel route can be looked for from the local traffic but that of the through traffic 50 per cent. would probably be diverted. If the traffic on each of these routes increases at 4 per cent. per annum compound until 1938 the through traffic would amount in that year to 124,000 on the Hook route and 56,000 on the Flushing route. On the basis that we have adopted the diversion to be expected would therefore be 90,000 passengers.

Harwich–Antwerp and Harwich–Zeebrugge.—We accept the view of the London & North Eastern Railway Company that there would be a diversion to the Tunnel route of 10 per cent. of the total passenger traffic carried by these routes. The traffic on these routes amounted in 1928 to 92,000 passengers, and if it increases at 4 per cent. per annum compound until 1938 it will have reached 135,000 in that year. The diversion that we anticipate on these routes amounts therefore to approximately 13,000 passengers. If to this figure is added the number (90,000) of passengers expected

to be diverted from the Hook and Flushing routes, it will be seen that the total diversion on the four Harwich routes would be 103,000 passengers out of a total of 479,000, *i.e.*, 21 per cent. of the whole.

Southampton–St. Malo and Caen.—We do not put the diversion to the Tunnel on this route higher than 15 per cent.

Southampton–Havre.—The Southern Railway state that, out of 65,000 passengers in 1928, 22,000 booked to Paris, 8,000 to other distant parts of France and 35,000 to places in the neighbourhood of Havre. On this basis, a diversion of 75 per cent. of the through traffic and 15 per cent. of the local traffic would amount to 42,000 passengers, if the traffic on this route increases at 4 per cent. per annum compound to 1938, *i.e.*, a diversion of 43 per cent. of the whole.

Gravesend–Rotterdam.—We do not anticipate any diversion to the Tunnel from this route.

In the following table will be found particulars regarding the present traffic, both local and through, on each of the several routes, the estimated amount of such traffic in 1938, the estimates of diversion of passengers from these routes to a Channel Tunnel that have been submitted to us, and our conclusions thereon.

Estimates of diversion of Passengers to Channel Tunnel.

—	Traffic, Actual.		Progression taken at 4 per cent. per annum Compound.		Estimate submitted by the Southern Railway. (The diversion factors other than for short sea route are applied to the 1928 traffic, and do not allow for progression.)		Estimate submitted by Southern Railway adjusted to allow for 4 per cent. Compound Progression.		Estimate of Southern Railway (adjusted), L.N.E. Railway and L.M.S. Railway in respect of their several routes.		Estimate of Diversion adopted by the Committee.	
Year	1928.		1938.		1936.		1938.		1938.			
	Passengers.		Passengers.		Diversion.	Passengers.	Diversion.	Passengers.	Diversion.	Passengers.	Diversion.	Passengers.
Route.												
Short sea (Dover–Calais, Folkestone–Boulogne), excluding local excursions...		1,029,000		1,523,000	% 100	1,157,000	% 100	1,523,000	% 100	1,523,000	% 100	1,523,000
Dover–Ostend—												
Local	335,000		496,000								15	74,000
Brussels and beyond ...	76,000		112,000								75	84,000
		411,000		608,000	10	40,000	10	61,000	10	61,000		158,000
Newhaven–Dieppe—												
Local	130,000		192,000								15	29,000
Beyond	129,000		191,000								75	143,000
		259,000		383,000	23	60,000	23	88,000	23	88,000		172,000
Tilbury–Dunkirk ...		79,000		117,000	32	25,000	32	38,000	32	38,000	32	38,000
Harwich–Hook—												
Local	85,000		126,000						...	...	...	...
Germany and Switzerland	84,000		124,000						50	62,000	50	62,000
		169,000		250,000	16	26,000	16	40,000		62,000		62,000

Harwich–Flushing—											...	...		...	...	
Local	26,000		38,000													
Germany and Switzerland	38,000		56,000							50	28,000		50	28,000		
		64,000		94,000	16	10,000	16	14,000				28,000				28,000
Harwich–Antwerp ...		64,000		94,000	16	10,000	16	14,000		10		9,000		10		9,000
Harwich–Zebrugge ...		28,000		41,000	16	4,000	16	7,000		10		4,000		10		4,000
Southampton–St. Malo and Caen		71,000		105,000	...	...	...	...		...		...		15		16,000
Southampton–Havre—																
Local	35,000		52,000											15	8,000	
Paris...	22,000		33,000											75	25,000	
Beyond	8,000		12,000											75	9,000	
		65,000		97,000	30	20,000	30	29,000		30		29,000				42,000
Gravesend–Rotterdam ...		27,000		40,000	...	...	...	...		...		...		...		...
Total, excluding short sea route...		1,237,000		1,829,000	11	195,000	16	291,000		17		319,000		29		529,000
Total, all routes ...		2,266,000		3,352,000	40	1,352,000	54	1,814,000		55		1,842,000		61		2,052,000

82. On the foregoing basis we estimate that if 1938 was the first year in which the tunnel was used, the number of passengers diverted to it would be 2,052,000. There is, however, a further factor which, though difficult to gauge, would no doubt operate to increase that figure. Experience shows that whenever an important new travel facility is introduced, *e.g.*, the opening of new through services, the introduction of third-class sleepers, &c., there is a net increase in the volume of traffic after all allowance has been made for diversion from other routes or other services. As has been shown (paragraph 67), the Channel Tunnel Company estimate that this new traffic attracted solely by the facilities offered by the Tunnel would amount to 1,687,500. The Southern Railway, however, do not anticipate that it will exceed 15 per cent. of the short sea traffic, *i.e.*, 173,471, on the basis adopted in their calculation of the probable volume of that traffic, or 228,000 if allowance is made for the normal growth of traffic between the present time and the date of the opening of the Tunnel on the routes from which diversion may be expected. The Chemin de Fer du Nord assume that the co-efficient of increase for the first five years will be 8·22 per cent., instead of the normal rate of 4·11 per cent. They calculate that on this basis the number of passengers likely to be carried by the Tunnel route will be 3,200,000 in 1940, which they assume will be the first year of its operation. The Nord Railway base this conclusion on two grounds. They accept the view referred to above that a Channel Tunnel, like any other new travelling facility, will tend to produce a new class of travelling public. Further, they consider that this increase would be larger in the case of a Channel Tunnel than it would be in that of a similar new travel facility between two countries having land frontiers. It is common knowledge that foreigners of the European nations do not for the most part willingly undertake journeys involving a sea crossing and that this distaste for the sea is an important factor in deterring many from visiting this country. A Channel Tunnel would entirely eliminate this factor and would, they believe, act as a substantial stimulus to the foreign tourist traffic to this country. On the other hand, some witnesses have expressed the view that a Tunnel might cause larger numbers of British subjects to visit the Riviera, Switzerland and other places on the Continent during the winter months, but that owing to the absence in this country of attractions of the type sought by foreigners at holiday resorts, the numbers of foreigners visiting this country for holiday purposes would not be likely materially to increase. Witnesses holding this view have further pointed out that, in that event, on balance a Tunnel would aggravate the present disproportion between the sums spent abroad by British subjects and those similarly spent in this country by foreigners. These are necessarily matters of conjecture, but it is not unreasonable to assume that some increase may be looked for in the number of foreign visitors due to the facilities offered by a Channel Tunnel.

83. In view of their great experience of the effect of the introduction of new facilities on the volume of traffic carried, we

invited the co-operation of the International Sleeping Car Company. Monsieur Garcey, Head of the Commercial Branch, in his evidence before us stated that the experience of his company showed that for the period 1904–28 the annual rate of progression amounted to 4 per cent. He added that for the first five years after the opening of the tunnel that rate would, in his view, be substantially increased. It would, he believed, amount to as much as 8 per cent. per annum.

84. There is, in addition, the question of the effect which a Channel Tunnel might have on the American tourist traffic to Europe. Of recent years American tourists have tended to an increasing extent to disembark at the ports of Southern Europe and to reimbark for America at the Northern French ports. In most cases Americans following this route omit a visit to England. From the best figures that we have been able to obtain it appears probable that in 1927 250,000 Americans who visited Europe did not visit this country. The view has been put before us that if there were a Channel Tunnel a larger number of American tourists would disembark at Southampton in preference to doing so at Cherbourg as at present. It has also been suggested to us that if there were a Channel Tunnel the present tendency of American tourists to disembark at the ports of Southern Europe would be reversed, and that a larger proportion of American tourists and business men would use the Northern route on their outward journey, and the Southern route (Genoa and Naples) on their return journey. It has also been suggested that the facilities provided by a Channel Tunnel may well lead to Liverpool regaining some of its former importance in the Transatlantic passenger traffic. It is pointed out that the sea passage from Liverpool to Montreal viâ the North of Ireland route would mean a saving of practically one day on the sea passage, that it would be particularly attractive for passengers from or to Chicago and the Middle West and that, if there was a direct train connection by the tunnel route between England and the principal European cities, this route would offer a definite saving of time. We do not wish to attach undue importance to these arguments, but we think that if there were a Channel Tunnel there might be some increase in the number of Americans visiting this country.

85. Any estimate of the increase in passenger cross-channel traffic directly attributable to the existence of a Channel Tunnel must necessarily be speculative, but, taking all the foregoing factors into consideration, we consider that the estimate of the Channel Tunnel Company is too high, and that of the Southern Railway too low. On the whole we think that it would not be unreasonable to assume in the first year of the operation of a Channel Tunnel a probable increase of passengers equivalent to 20 per cent. of the probable volume at that date of the short sea traffic, viz., 305,000 passengers.

86. For the purposes of comparison we set out in the following table the probable traffic on the basis (*a*) of the diversion factors

suggested to us by the Southern Railway, (*b*) on the same basis, with the number of passengers adjusted as indicated in paragraph 82, and (*c*) on the basis which we consider reasonable. As shown in this table we conclude that if a Channel Tunnel were opened to traffic on the 1st January, 1938, it might be expected to secure in that year 2,357,000 passengers :—

ESTIMATE of Passengers through Channel Tunnel.

Tunnel open for Traffic on January 1st.	1936.		1938.		1938.	
	Southern Railway unadjusted.		Southern Railway adjusted.		Estimate adopted by the Committee.	
Route.	Diversion.	Passengers.	Diversion.	Passengers.	Diversion.	Passengers.
	%		%		%	
Short sea	100	1,157,000	100	1,523,000	100	1,523,000
Dover–Ostend ...	10	40,000	10	61,000	26	158,000
Newhaven–Dieppe	23	60,000	23	88,000	45	172,000
Tilbury–Dunkirk ...	32	25,000	32	38,000	32	38,000
Harwich–Hook, Flushing, Antwerp and Zeebrugge	16	50,000	16	75,000	21	103,000
Southampton – St. Malo and Caen ...	...	...	...	...	15	16,000
Southampton–Havre	30	20,000	30	29,000	43	42,000
Total Passengers	40	1,352,000	54	1,814,000	61	2,052,000
Attracted by tunnel facilities ...	(*a*)	173,000	(*a*)	228,000	(*b*)	305,000
Total Passengers	...	1,525,000	...	2,042,000	...	2,357,000

(*a*) 15 per cent. of short sea traffic.
(*b*) 20 per cent. of short sea traffic.

(ii.) *Air Traffic.*

87. In the foregoing paragraphs we have considered only the Channel passenger traffic carried by boat. Recent years have, however, witnessed a substantial growth of air travel between this country and the Continent. The number of passengers carried in each of the last four completed years is as follows :—

Year.	Passengers carried.
1925	20,721
1926	25,524
1927	28,764
1928	43,179

A further increase was expected for 1929 and again in the near future when it is found possible to introduce night services on the air lines.

88. It will be seen from the above figures that cross-Channel air traffic has developed rapidly in recent years, and that its volume is likely still further to increase. The total figures represent, however, only a very small proportion of the total cross-Channel passenger traffic. The rates at present charged for the journey from London to Paris by air are slightly higher than those for the same journey first class by train and boat, but are less than those charged on the *de luxe* (Golden Arrow) boat service. It is, however, important to bear in mind that the fares charged by the air lines in this country and on the Continent are not economic rates, and are only rendered possible by the existence of Government subsidies. It is not possible to estimate what would be the effect on the existing volume of air traffic if these subsidies were withdrawn. It cannot, however, be doubted that there would be some immediate contraction accompanied by a slowing down in the present annual rate of progression. Civilian air services have not in fact emerged from the period of initial struggle, and have yet to face conditions of open competition. We do not doubt that they will do so successfully when that time comes, but we believe that for the present and for many years to come they are unlikely to offer serious competition to railway transport. From the estimates submitted to us, it appears probable that two out of every three of the persons who now use the London–Paris air route are men travelling on business. We think that in the main this is the class of passenger who is likely in an increasing degree to travel by air in preference to going by rail. The higher cost and greater discomfort of air travel are not likely to act as deterrents in view of the business advantages offered by more rapid travelling. Comfort and safety depend on the accidents of weather just as the boat services do, and in that respect air services share the disadvantage of the boat services. Speed to some extent outweighs this consideration. In so far as this view proves to be correct, the progressive development of air services may be expected to be of benefit to the countries between which they are operated, and by affording better means of communication to act as a stimulus to trade between those countries. Air lines are not likely ever to compete with boat and rail transport for the carriage of heavy goods. Increases in the volume of international trade due to development of air travel for business purposes are likely to be reflected in increases of railway-borne goods traffic between countries connected with air services.

89. In general we consider that, as regards passenger traffic, the London–Paris air services are not likely to be affected adversely by the advent of a Channel Tunnel. These services will no doubt develop considerably during the next ten years, but we do not think that they are likely to offer serious competition to a Channel Tunnel. As regards the carriage of goods, air services at present only compete

with other forms of transport in special commodities of high value or those commodities for which rapidity of transport is sufficiently important to outweigh the higher cost. Some of the latter traffic might be diverted to a Channel Tunnel. From the point of view of the Tunnel, we do not think that air competition for goods traffic would prove a serious factor.

(b.) Goods Traffic.

90. As in the case of passenger traffic, a considerable volume of goods traffic will be provided for a Channel Tunnel by the closing down of existing Southern Railway Steamship services and their transfer to the tunnel route. The extent to which a tunnel might be expected to attract goods traffic at present moving by other routes will naturally depend in large measure on the rates which it offers. Changes in rates charged for transport movement, like other charges made for goods or services rendered, do not always result in proportionate increases or decreases in the volume of sales or commodities moved, as such resultant alterations in volume depend also upon the demand. For example, a 20 per cent. reduction in the rates charged for a commodity produced in the South of France might be sufficient to double the demand for that commodity in London. There are, however, other important factors to which due weight must be given. These include speed, elimination of handling, reduction of packing, insurance rates and reduction of liability to claims. If the charges made for the use of a Channel Tunnel were founded solely upon the basis of making it a profitable investment, there would be little risk in the early stages of high charges, as the level of rates would be so set as to induce the maximum possible freight movement, though, later, rates might tend to rise. The rates which a railway can charge for the goods which it carries depend partly on their value and partly on the competition, either of markets or of rival means of transport with which it is faced. Even in Great Britain there are few railway rates which are not limited by coastwise steamer or road vehicle competition. Cross-Channel rates are not in reality cross-Channel rates, but Paris–London rates for certain classes of traffic, or Calais–Boulogne–London rates for other types of traffic. The latter rates are set primarily by water competition from the French Channel ports to the Thames; the former are set, in the case of valuable traffic, to some extent by air competition. The unexpected competitive power of air transport is well illustrated by an example which was brought to our notice in which a firm in the Midlands found it profitable to transport light steel castings of high value to and from Switzerland by air. We understand that in this case the determining factor was the speed and regularity of the service. As regards the Calais–London and Boulogne–London routes, the situation is complicated by the fact that the Southern Railway owns both cross-Channel steamers and railway routes between Dover and Folkestone and London. Rates are therefore quoted

from the French Channel ports to London, and it is not possible to ascertain upon what proportions such revenue is divided between railways and steamers.

91. Of the goods traffic which might be attracted to the Tunnel that at present passing through Dover, Folkestone and Newhaven is of particular importance. Details of that traffic for 1927 are given in Appendix III. These figures are derived from the "Annual Statement of the Trade of the United Kingdom" issued for that year. Excluding imports of coal in 1926 and 1927 the trade may be summarised as follows:—

——	Imports.	British Exports.	Re-exports.
	£'000.	£'000.	£'000.
1923–27— *Average.*			
Dover	18,298	4,335	4,668
Folkestone	13,924	1,647	1,892
Newhaven...	12,819	3,361	1,326
Totals	45,041	9,343	7,886
1927—			
Dover	17,581	4,998	4,289
Folkestone	6,591	1,203	1,895
Newhaven...	8,712	2,907	1,196
Totals	32,884	9,108	7,380

92. In Table I of Appendix III, imported goods in 1927 are classed as (*a*) perishable articles, (*b*) valuable and fragile articles, and (*c*) other goods. The classification is only a rough one, and it may well appear that motor cars, cycles, rubber goods, and electrical goods should have been included in class (*b*), raising the value of imports in that class from £17,890,000 to £18,777,000. Tables II and III show the main groups of exports and re-exports.

93. The largest single class of goods imported through the three ports consisted of textiles and apparel and amounted in value to £17,540,000, or nearly 53·4 per cent. of the total imports, while exports of British-made textile goods and apparel were valued at £3,807,000. Of these exports about one-third (£1,290,000) passed through Newhaven–Dieppe, apparently for convenience of distribution locally or to the centre and south of France, and would therefore probably not be diverted to a Channel Tunnel.

94. We think it reasonable to expect that a Channel Tunnel service would reduce costs of transport (including packing, breaking bulk, port dues, insurance, &c.) sufficiently to divert to it a considerable part of existing imports from the Continent which are at present brought in by other routes. In order to obtain some concrete evidence on this question, we obtained in November 1929 a number of quotations on specified articles for particular routes. The wide variation in these quotations is very striking and constitutes a severe handicap to exporters. In the case, for example,

of Berlin to Bedford, such widely differing rates as £4 15*s*. 4*d*. and £7 0*s*. 9*d*. per ton were found. In another case (Birmingham to Barcelona) the rates varied from £3 15*s*. 7*d*. to £7 8*s*. 9*d*. per ton. These variations led to an examination of hypothetical railway rates between these centres over an all railway route through the tunnel, on the assumption that existing railway rates would apply for the through journey with a suitable addition for the portion of the journey in the Channel Tunnel. The examination showed that to produce rates competitive with those now charged by existing rail *cum* sea routes the additional charge for the Tunnel would not be so great as to be outside the normal range of competitive rate quoting. The possibility must therefore be reckoned with that the Channel Tunnel route by rating alone apart from the advantages of speed, regularity of service, and avoidance of handling, might successfully compete for traffic between the Midlands and continental towns other than that carried at present through the Channel Ports. In this connection it is interesting to note that the elimination of the sea crossing by the establishment of a through rail connection between this country and the Continent would have the effect of creating an all-rail route between (say) London and important centres in Northern France such as Lille. By the Tunnel route the distance to London from Lille would be approximately 170 miles as compared with 190 miles from Manchester, 196 miles from Hull and 220 miles from Leeds.

95. Our general conclusion is that for imports the Tunnel would secure a substantial traffic at present rates in view of the greater speed and regularity of its service compared with that of its competitors, though bulky and less profitable traffic would continue to use the sea route. The same factors would operate in the case of exports. On the Channel routes imports largely exceed exports, and this might well prompt the companies operating the Tunnel to offer specially attractive rates to exporters, more particularly as they would otherwise have to return trucks empty to the Continent. By doing so they would do something to balance their traffic, and would tend to secure freight at present carried by shipping companies. From the estimates with which we have been furnished it appears that the goods traffic conveyed by regular routes between England and France and Belgium which would be susceptible to competition by a Channel Tunnel amounted in 1928 to about 530,000 tons excluding that carried by the Harwich–Zeebrugge train ferry. Of this traffic, only about 22 per cent. was carried by the Southern Railway on the Dover–Calais and Folkestone–Boulogne routes. The Southern Railway estimate that the receipts obtained by a Channel Tunnel in respect of goods in the first year of operation would show an increase of 50 per cent. over those now obtained on the two boat services referred to above. Tonnage alone is admittedly not a good guide to the value of freight, but we think that this estimate is a moderate one.

VII.—ECONOMIC QUESTIONS.

(a.) Employment.

96. We have devoted special consideration to the effects which the construction of a Channel Tunnel might be expected to have on the volume of employment.

97. The Consulting Engineers estimate that the building of the British half of the pilot and drainage tunnels would give direct employment to an average of 250 men per annum, spread over a period of five years. On the completion of this stage, they estimate that for the remaining (three-year) period when the main traffic tunnels would be under construction, direct employment would be given to an average of 1,550 men on the British section of the Tunnel. In addition, further direct employment of which it is difficult to estimate the amount, would be required for the provision of the exchange station at Sandling,and for such other developments as the Southern Railway might undertake.

98. It will thus be seen that the amount of direct employment afforded by the scheme is relatively small. Its indirect effect, however, on employment in the iron and steel, coal and electrical industries is likely to be considerably larger. Very large quantities of cast iron (estimated by some witnesses at 500,000 tons) would be required for the lining of the tunnels. In addition, the large quantities of railway metals and electrical equipment required would also give additional employment in the industries concerned. Estimates of the indirect effect on employment of such a scheme must necessarily be speculative unless based on data gained in connection with similar works. For this reason, we invited the Consulting Engineers to give us their opinion in the light of their experience. They consider (Section (1) (*e*)) that, during the first (five-year) period when the pilot and drainage tunnels were under construction additional employment would be indirectly afforded to an average of 750 men per annum. They calculate that during the subsequent (three-year) period when the main traffic tunnels would be under construction the additional indirect employment would amount to an average of 4,500 men per annum.

99. During the construction period existing services both passenger and goods would be maintained as at present, and there would be no falling off of direct employment on account of the tunnel. The position would, of course, be materially changed as soon as the tunnel was actually opened for traffic. It is probable that the Ostend route would be maintained, but we are informed by the Southern Railway and the Chemin de Fer du Nord that they would probably close down their present boat services on the Dover–Calais and Folkestone–Boulogne routes. Large reductions of staff at the Marine stations at Dover and Folkestone would result from a closing of the boat services. The Exchange Station at Sandling Junction would, however, require a fairly large

staff and would absorb a considerable proportion of the labour displaced at the Marine Stations. The Southern Railway have furnished us with an estimate from which it appears that at Dover there would probably be a reduction of 143 in the dock staff and 37 in the Dover Marine Station staff; and that at Folkestone reductions on a more or less similar scale might be expected. The marine staff on the cross-channel boats at present numbers 763 officers and men who would lose their present employment. From the foregoing figures, it seems likely that at the opening of the tunnel the Southern Railway would reduce their present staff by about 1,000 men. The Folkestone Harbour Board is owned and operated by the Southern Railway and allowance has been made in the foregoing estimates for any reductions that might be made in its staff. As regards Dover, the Register of Dover Harbour has informed us that it is anticipated that a considerable number of men now employed by the Harbour Board would lose their employment on the opening of a Channel Tunnel. In addition there is a possibility of further labour being displaced in the cross-Channel Short Sea Trades, if the fears expressed by the Shipping Companies (paragraphs 121–124) prove to be well-founded.

(b.) Agriculture.

100. We now turn to the consideration of the effects that the construction of a Tunnel might have on British agriculture. On this question we have taken evidence from the Ministry of Agriculture and Fisheries, from the representatives of the Fruit and Vegetables Committee, and of the Glasshouse Growers' Sub-Committee of the National Farmers' Union, and from the Railway Companies. We deal with this problem at some length as there is no doubt that in southern and eastern England some sections of the farming community entertain feelings of apprehension regarding the possible consequences to their industry. The view held is that as the result of the improved transport facilities offered by the Tunnel, agricultural imports from the Continent would increase at the expense of home production. The products which it is thought would be most likely to be affected are fluid milk, cream, fruit, vegetables and flowers. Comparative nearness to the market at present gives these products a certain competitive advantage over the foreign producer. It is feared that this advantage would largely disappear if a Tunnel were constructed, and that the home producer would have to face the competition of foreign producers whose costs of production were lower than his own.

101. From a marketing point of view, the question is primarily one of the extent to which the construction of a Channel Tunnel would increase foreign competition by reducing the cost, or by increasing the efficiency, of the transport of agricultural produce to this country from the Continent. Perishable goods naturally tend to travel by the speediest route or that involving least

handling. It is, therefore, not unlikely that other conditions being equal a Channel Tunnel would exercise a special attraction for the import of certain classes of agricultural produce. Moreover, the existence of a Tunnel might stimulate or even in some cases create a trade in the kinds of produce specially grown for the English market. How far the Tunnel would exercise such an influence cannot be anticipated with certainty, but in the following paragraphs we examine the various classes of produce involved and endeavour to estimate the probable effect in each case. As will be seen by reference to the map (Appendix VII) furnished to us by the Ministry of Agriculture and Fisheries, the bulk of the agricultural produce imported from the Continent through the ports likely to be affected by a Channel Tunnel does not come from the immediate neighbourhood of those ports, but from producing areas situated at a considerable distance from them.

(i.) *Cereals.*

102. The traffic in cereals through the ports likely to be affected by the Tunnel is negligible, and imports into this country are unlikely to be stimulated, in any way, by its construction.

(ii.) *Meat.*

103. As with cereals, the bulk of the meat supply of this country comes from extra-European sources, and will, no doubt, continue to do so whether a Channel Tunnel is built or not. At present, the import of fresh meat from the Continent is prohibited by an embargo imposed in 1926 as a protection against foot-and mouth disease. If this were, at any time, removed, the pork, veal, and lamb trade of Holland and, to a less extent, Belgium with this country might revive, but the centres of production are, for the most part, outside the range of the Tunnel. There is little likelihood of fresh sources of supply more accessible to the Tunnel being developed. Favourable "through" rates might possibly stimulate veal production in the Thierache region of France, where dairying is extensively practised, but, at present, owing to the virtual prohibition of imports into France, the domestic demand in that country for meat allows no margin for a profitable export trade.

(iii.) *Eggs.*

104. The traffic in eggs through the ports of Dover, Folkestone and Newhaven in 1927 amounted to 60,000 great hundreds, or $\frac{1}{4}$ of 1 per cent. of the total imports. It is possible that a Channel Tunnel might absorb a proportion of the supplies now entering other English ports, but even if it secured a trade equal in volume to the whole of the supplies imported from France, Belgium, Switzerland and Italy in 1927, the resulting traffic would only represent 11 per cent. of the total imports. It is doubtful whether a Channel Tunnel would

increase production for export in those countries to any considerable extent. Existing means of transport from the Continent to this country are, it is understood, considered by the big importing firms to be highly efficient. The saving in time which a Tunnel might effect would be too small to have any appreciable effect.

(iv.) *Poultry.*

105. As regards poultry, the position is different, as speed in transit and reduction of handling have an important influence on the appearance and general condition of the supplies reaching the market. Supplies from Holland would not be affected by a Tunnel because it would not be able to compete successfully with the existing facilities offered by the Shipping Companies on the Amsterdam–London route. Supplies of live and dead poultry from France, Belgium, Italy and Switzerland in 1927 amounted to 18 per cent. of total imports. The chief exporting areas in France are the Vendée, the Bresse area, east of the River Saone, the Bourbonnais in Central France, the district around Le Mans (Normandy) and the Gambais–Houdan area to the south-west of Paris. Supplies from these areas are mainly exported from Boulogne and Honfleur. Owing to the competition between the State-owned and the privately-owned railways, much of the traffic which would naturally go to Honfleur has been diverted by special rates to Boulogne. A Channel Tunnel would take the Boulogne traffic, but not that which at present goes viâ Honfleur. Imports from France are mainly received in the winter months, 75 per cent. of the total being imported in the month of December. In Belgium, the main production area is the district around Malines, supplies from which are exported mainly by the Zeebrugge–Harwich route or viâ Antwerp or Ostend and London. It is possible that some supplies from this source might be diverted to a Tunnel, but neither in France nor in Belgium are the production areas sufficiently favourably placed for a Tunnel to make a great difference to the traffic. Italian supplies which are now shipped from Boulogne or Calais would, however, probably go by the Tunnel route. For these supplies, the elimination of transhipment and the utilisation of refrigerated "through" cars would probably ensure better condition and better prices in this country. Hungarian supplies which are shipped from Antwerp, Zeebrugge or Ostend might also be diverted to the Tunnel. During the summer months, however, supplies of English poultry on the markets are large and there is little demand for imports. At present imported poultry represents 25 per cent. of total supplies.

(v.) *Dairy Produce.*

106. The present traffic in dairy produce between the areas on the Continent within the probable range of a Channel Tunnel and this country forms a negligible proportion of the total imports into the United Kingdom. Moreover, as far as cheese is concerned,

the kinds produced on the Continent are, in the main, special varieties which are not directly competitive with those produced in this country. Exports of butter and cheese from Holland would probably not be affected by the Tunnel. In France, the chief producing area for butter is Lower Normandy, but exports from this area are sent viâ Cherbourg and would probably not be affected.

107. Apart from a few more or less experimental shipments from Holland and Denmark in recent years, the fluid milk market in this country is, at present, unaffected by imported supplies. Leaving aside the question of rates, the sea passage and the handling involved under present conditions of transport are certainly a deterrent to potential exporting countries. The establishment of "through" transport of milk in bulk in specially constructed tanks between surplus producing areas on the Continent and the consuming markets in this country would, however, probably promote the growth of this traffic. Holland is, at present, the nearest potential source of supply. It has a large, highly developed dairy industry with a large export trade in dairy products. The industry, particularly in Friesland, is centred at factories which would not require extensive adaptation to enable them to undertake the shipment of milk. It is possible that the price levels for milk in this country and in Holland might, in the summer months, allow a small margin for the profitable export of milk to this country provided costs of transport were no higher than at present. As regards France, it is unlikely that an export trade in fresh milk would develop to any extent, unless the Tunnel route were markedly cheaper than the present services, as it would hardly pay producers in this district to undertake the costs and risks of export.

108. Of the imports of other kinds of milk products, only fresh cream is likely to be affected by a Channel Tunnel. In 1927, imports of cream from all sources amounted to rather less than 125,000 cwt., which probably represented less than one third of the total supplies in Great Britain. Nearly 75 per cent. of the imports were, however, from the Irish Free State and 15 per cent. from Denmark. The trade of these countries would certainly not be affected by the construction of a Channel Tunnel. The greater part of the remaining 10 per cent. came from Holland, although 4,601 cwt. was received from Switzerland. Supplies from France, amounting to only 295 cwt. were negligible. Since the enforcement of the Preservatives Order in 1928, imports of cream proper from foreign countries have been considerably reduced, although increasing supplies have arrived in this country in the form of "artificial" (reconstituted) and tinned cream. Further, with the development of the trade in reconstituted cream for use in hotels and by confectioners, the demand for long-distance natural cream for this purpose has diminished.

109. As regards natural cream for household use, proximity to the market is, if anything, more important than for fluid milk owing to the greater delay which is usually experienced in passing

it into consumption. As with fluid milk, the rapid perishability of cream restricts the area from which supplies can be drawn. It is therefore not likely that the construction of a Tunnel would have any appreciable effect on British production of this commodity.

(vi.) *Fruit.*

110. Imports of fruit from the Continent of the kinds competitive with those grown in this country consist chiefly of apples, pears, cherries, plums, strawberries and currants. In 1927, imports of apples from France, Belgium, Switzerland and Italy together amounted to only 4 per cent. of total imports. These supplies are mainly of low-grade fruit, chiefly cider apples, and in the case of French supplies, are mainly exported from Cherbourg and Honfleur. A Channel Tunnel would not be likely to affect the position, since the supplies are not highly perishable and are not generally of a quality to bear high transport costs. Imports of pears from the Continent, especially from Belgium and France, form a somewhat larger proportion of total imports. A proportion of the supplies received from France and Belgium are of high quality, but the chief producing areas are outside the effective range of the Tunnel route. The total imports of pears into Dover, Folkestone and Newhaven in 1927 were less than 5 per cent. of the total imports. Imports of cherries and plums are mainly derived from France, Belgium and Italy, but the bulk of total supplies are home grown. The chief producing area in France is the Rhone valley and this region would benefit from the Tunnel facilities. Supplies from Italy and, to some extent, Belgium might also be diverted from the Harwich–Zeebrugge ferry to the Tunnel. The rapid perishability of these fruits and their susceptibility to damage in handling would probably render the Tunnel route attractive to Continental senders. Some increase in the traffic is not unlikely from areas readily accessible to the Tunnel. It is, however, important to note that cherries and plums arrive in this country from France before the English season starts and compete with those produced at home only for a short period during the overlapping period. Moreover, in the last few seasons, imports of cherries from France have been largely prohibited—from mid-June onwards—on account of cherry-fly. Imports of strawberries into this country come almost exclusively from Holland and France. In France, the chief producing area is in Britanny, and exports mainly proceed to this country viâ Plougastel and Plymouth. Neither this area nor that of Holland would be affected by a Tunnel. The principal tomato exporting countries—the Canary Islands, the Channel Islands and the Netherlands—are quite outside the range of the Tunnel. Imports from Spain are also unlikely to be affected. French supplies grown mainly in Lower Normandy, and amounting to less than 2 per cent. of the total supplies available in this country, are exported chiefly from St. Malo and would not proceed by the Channel route. Small supplies are received from Belgium. Supplies from Spain, Italy and France mainly enter this country during the off-season, and during such season do not compete with the home-grown

product. There is, however, an overlapping season when both foreign and home-grown produce is on the market, and during this short but important time competition would be increased to the detriment of the home producer. Imports of grapes are principally received from Spain and Portugal—by direct sea route—although Holland and Belgium also send considerable quantities. Apart from a proportion of Belgian supplies, however, these areas of production would not be affected by a Tunnel.

(vii.) *Vegetables.*

111. As regards potatoes, only the early kinds grown in Spain would travel by the Channel route, as after the first ten days of the season, when it is profitable to send Spanish early potatoes by the fast goods train across France to Boulogne, these supplies are sent by direct boat from Barcelona. The Channel Tunnel would not increase the competition of imports of potatoes on the English market because home-grown supplies are not available until later in the season. Imports of onions from the Continent would be unaffected by the Tunnel.

112. Of other kinds of vegetables, those exported between January and June would be mainly affected by the Tunnel. When English supplies appear on the market in large quantities it does not generally pay to send vegetables to this country. Apart from the Dutch supplies, which would not, in any case, go viâ the Tunnel, the bulk of the imports of early vegetables come from France and, to a less degree, Belgium, Spain and Algeria. Not all the exporting areas would, however, be affected by the Tunnel. The Roscoff and St. Malo and Barfleur broccoli exports, for instance, would be unaffected, as also would cabbage exports from Cherbourg and the exports of peas from Plougastel, which takes place in May. It is also unlikely that a Tunnel would stimulate greater exports of lettuce from Belgium. The Tunnel would probably benefit exporters of early vegetables from Barcelona, as this produce, at present, travels overland viâ Cerbere to Boulogne. In France, the Perpignan area (on the Gulf of Lyons) which exports lettuce, radishes, &c., chiefly in December–April, the Cavaillon district (in the Rhone valley), whence asparagus is consigned in March–May, the early spring vegetable traffic from the Nantes area, the area around Paris which exports primeurs to the London market viâ Dieppe and Newhaven, the small radish exporting area round Boulogne might benefit to some extent by the construction of a Channel Tunnel. In Belgium the small quantities of chicory grown around Brussels and Ghent and exported to this country viâ Antwerp and Harwich might also benefit from the facilities afforded by the Channel Tunnel. With produce of relatively high value in proportion to its bulk and very rapid perishability, such as early vegetables, speed in transit and the minimum amount of handling are of greater importance than the actual cost of transportation. To the extent that a Channel

Tunnel would enable this produce to reach the market in this country quicker and in better condition than at present, it would probably tend to increase imports.

(viii.) *Flowers.*

113. In recent years, fairly substantial imports of fresh flowers have been received from the Continent, the two chief sources being Holland (for tulips, &c.), and the French Riviera (for roses, carnations, narcissus and mimosa). A Channel Tunnel would not be likely to affect the former, but it might stimulate the latter. At present, the French flower traffic travels by special express service to Boulogne. The trade, is, however, only profitable in the early months of the year before English produce enters the market, and is necessarily relatively small.

(ix.) *Conclusions.*

114. It will be seen from the foregoing survey that many kinds of agricultural produce would be little if at all affected by the construction of a Channel Tunnel. In this class fall cereals, meat, eggs, poultry and most forms of dairy produce. As regards cream, we do not consider that there are any reasonable grounds for believing that the home trade is likely to be materially affected. As regards fluid milk, we are advised that unless the rates charged for the Tunnel route were markedly lower than those at present in force, it would hardly be profitable for foreign producers to export to this country, in view of the capital expenditure that would be involved, the cost of longer transport and the small differences between the wholesale price of milk in this country and on the Continent.

115. As regards fruit and vegetables, also, a large part of the imports into this country do not compete directly with home production. This is due in some cases to a difference in quality between the home-grown produce and that imported from abroad. In other cases it is caused by the imported produce coming on the market at a season when the home-grown produce is not and could not be available. There are, however, a number of cases in which imports do compete directly with home-grown fruit and vegetables. In some instances the area of production is so far removed from the Channel ports that the construction of a Tunnel would not alter the existing routes and would therefore have no effect one way or the other on home production. There remain those classes of fruit and vegetables which are or can be grown more cheaply abroad in regions that would be benefited by a Channel Tunnel. Of these the principal are grapes, cucumbers and flowers. In England these are all grown, for commercial purposes, under glass. It is estimated that capital amounting to upwards of £10,000,000 to £12,000,000 has been invested in the glass-house industry. The annual value of the crops produced is stated to be £5,000,000. This industry

witnessed a considerable expansion in the immediate post-war years; but more recently it has encountered difficulties which have lead to a contraction of the area under glass. The foreign producer already enjoys the advantage of a more equable climate and lower labour and maintenance costs; and it has been represented to us that the construction of a Channel Tunnel would accentuate these advantages, and to that extent worsen the competitive power of the British producer. Witnesses appeared before us who claimed that the opening in 1924 of the Harwich–Zeebrugge train ferry had in fact produced on a smaller scale effects identical which they predicted as likely to follow the opening of the Channel Tunnel. This contention is not, however, borne out by the traffic figures for that route furnished to us by the London and North-Eastern Railway which show that the imports of fruit and vegetables by ferry from Zeebrugge amounted in 1924 to 22,885 tons, in 1925 to 7,008 tons and in 1928 to 19,900 tons. It is true that these figures include fruit and vegetables not grown under glass as well as those so grown and that if it were possible to separate the former, the figures might be somewhat different. The industry has no doubt had substantial difficulties to face in the period under review. Part of the explanation of these difficulties should, however, in our view be sought elsewhere. The existing arrangements for the collection and transport to market of the produce of the glass-house industry appears to us to leave much to be desired. We are informed that the machinery for the collection of produce at the nurseries is inadequate; and that though special trains are now run from some large producing areas to London, the full advantage from lower rates for bulking is not at present obtained by producers. At present rates the cost of road transport is only very slightly above that of transport by rail. We believe that a thorough examination of existing methods of marketing fruit and vegetables would be advantageous both to the growers and to the railway companies. Improvement of these methods would, we believe, enable the growers to bring their produce to market more cheaply, more rapidly and in better condition than is possible to-day and would secure for the railways a larger and more profitable traffic.

116. To sum up, we think it probable that, for the special classes of fruit and vegetables referred to above, the opening of a Channel Tunnel would be followed by some increase of foreign competition. Closer proximity to their market should, however, continue to enable the British producer to bring his crop to London more rapidly and in better condition than is possible for his foreign rival. For the reasons explained in the preceding paragraph, these natural advantages could, we believe, be increased by more effective co-operation between the producers and the railways.

(c.) Industry and Trade.

117. In the hope of obtaining the views of the trading community, we invited the assistance of the Association of British Chambers

of Commerce, which, at our request, communicated a number of questions on the subject to its constituent Chambers of Commerce throughout the country. From the replies received it appears that on the general question, with the exception of the Birmingham, Bradford and Dover Chambers of Commerce, the Chambers favour the construction of a Channel Tunnel, provided that a satisfactory financial scheme can be evolved and that its construction would not adversely affect the trade of the country. The Chambers are doubtful whether a Tunnel would confer any substantial benefit on the export trade. They consider that any advantage derivable from the construction of a Tunnel would be enjoyed by foreign competitors of this country and would prove a further handicap to the British trader in maintaining his hold on the home market. They add, however, that a Tunnel would probably increase the passenger traffic between England and the Continent, but that as regards goods traffic the advantage would lie with the importer of foreign goods rather than with the British manufacturer.

118. Of the Chambers opposed to the construction of a tunnel, Birmingham and Bradford base their objections on the ground that the export trade would not benefit, but that imports would increase, with results disadvantageous to British traders. In addition, the Bradford Chamber express the view that the facilities offered by a tunnel would be of no advantage to the North of England, as existing routes for goods would still be quicker. The Dover Chamber is opposed to the scheme on the ground of the injury which it would do to local interests. The London Chamber replied that they were not opposed to the scheme provided that no part of its cost formed a charge on the national revenue. They considered, however, that its economic effects, especially in relation to through freight rates from the Continent should be closely examined. The Glasgow Chamber favour a tunnel provided it was constructed on economic lines and not at the public cost, as they consider that it would do much to encourage passenger traffic between the Continent and this country and *vice versâ*. As regards goods, they do not think it would assist the heavy trades between Glasgow and the Continent, but they believe it might be of advantage to traders in the Midlands and the South of England. The Manchester Chamber support the proposal on the general principle that any extension of efficient facilities for transport and communication must of necessity lead to extended trade. They add that as freight transportation would be definitely quicker the existence of a tunnel would, in their view, make possible trade which is never even contemplated to-day.

119. We have found great difficulty in obtaining expressions of opinion from representative bodies of manufacturers. Such expressions of opinion as we have received are, for the most part, either adverse or indifferent to the idea of a tunnel. The Lace Finishing Association express the view that the export trade would not benefit as a result of the construction of a tunnel, but that imports would increase with disadvantageous results to their industry. The Nottingham Chamber of Commerce, which we consulted at the

same time, are, however, in favour of a tunnel. The Silk Association of Great Britain and Ireland express similar fears to those of the Lace Finishing Association, as they believe that a tunnel would not benefit the silk industry. In reply to an inquiry, the Coventry Chamber of Commerce stated that they had consulted a leading representative firm of that industry in that city, who had replied that, in their view, the construction of a tunnel would not injure or benefit their business in any way, and that they were therefore unable to express themselves for or against the proposal. The British Pottery Manufacturers' Association also stated that they had no observations to offer on the matter. The foregoing examples show the indecisive result of this part of our inquiry.

(d.) Shipping.

120. The Chamber of Shipping of the United Kingdom, in response to an invitation to give evidence before us, replied that shipping as a whole would not be affected by the construction of a Channel Tunnel. They nominated, however, witnesses to give evidence on its effect on the regular shipping lines established in the short sea trades, which they anticipated would be adversely affected. The conveyance of passengers by these shipping companies is negligible, so that the important consideration is the competition for cargo.

121. Of the two companies regarding which particulars were put before us, it appears that the vessels likely to be affected by Tunnel competition number thirty-six, that the average number of voyages of these vessels is 1,950 per annum, and that the cargo carried annually amounts in the aggregate to 1,320,000 tons. The number of seamen employed on these vessels was given as 900. Shore labour (mostly in regular, as distinct from casual, employment) on wharves, quays and docks, railway sidings and road transport was put at 1,000, and clerical labour at 400. If to these figures are added the men employed in warehousing, which is a more usual feature of the short sea trades than of modern oversea trade, it is probable that the total number of men employed is not far short of 2,000.

122. The shipping companies on behalf of which evidence was given are engaged in running fast, regular and frequent cargo services between London and Amsterdam, Antwerp, Boulogne, Bordeaux, Bremen, the Charente, Dunkirk, Ghent, Hamburg, Havre, Ostend and Rotterdam. We doubt whether all these services would be affected by competition from the Tunnel, as it may be assumed, for example, that traffic now going from Dresden viâ Hamburg would not be attracted to Calais. On the other hand, we were informed that a considerable volume of traffic at present goes from Milan and Switzerland viâ Hamburg, which could be sent with advantage viâ Calais if the Tunnel were in existence. It was stated that 10 per cent. of one shipping company's inward

cargo from a near French port was of Italian origin. We were, moreover, impressed by the variety of traffics and of routes now converging on the nearer continental ports, even from comparatively distant countries such as Poland and Spain, much of which, we think, might be diverted to the Tunnel. A Tunnel would facilitate the through routing of exports from this country to all parts of Europe. The rail haul by the Tunnel would in many cases be shorter than by the present routes. In others it would probably not be so much longer as to counter-balance other advantages offered by the Tunnel.

123. We do not doubt that a Channel Tunnel would be a serious competitor to the shipping companies engaged in the short sea trades, particularly those running services with the nearer continental ports. A Tunnel would be able to offer more rapid and more frequent services and, in addition, there would be one less handling on the Tunnel route. A Tunnel would thus enjoy the advantage now held by the shipping companies, which in normal circumstances have one less handling than railways. It is, however, in regard to rates that the greatest danger to the companies engaged in the short sea trades is to be apprehended. It is no doubt true that sea transport is in general cheaper than other forms of transport. We were informed that even on the cross-Channel services where the railways undertake sea carriage, the rate charged by the railways is normally higher than that charged by the shipping companies. Even if this were to continue to be the case, it does not, however, necessarily mean that a trader would have to pay more for transit by the Tunnel route than by the sea route. It is probable that a large part of the goods traffic obtained by a Channel Tunnel would be carried on through rates. To a certain extent this practice obtains to-day in regard to traffics carried by railway steamers and train ferries. The shipping companies expressed apprehension regarding its extension, as they claim that under this system the rate charged for the sea portion of the transit is cut so low as, from their point of view, to be uneconomic.

124. In the Section dealing with goods traffic (paragraph 95) we have expressed the view that the railways would have every inducement to quote very low rates for export traffic by the Tunnel route in order, on their return journey, to fill trucks which had entered this country with imports and which otherwise would be returned empty. This would confer substantial benefits upon British manufacturers. Provided they were not offset by a corresponding increase in tariff barriers abroad, such rates might to some extent counteract any adverse trade balance that the Tunnel might have a tendency to create. The quotation of nominal rates on return trucks would adversely affect the outward carryings of the short sea trades. In the case of one of the principal companies exports amount to 30 per cent. of the total cargo carried. We think that the Tunnel might

enable the railways to capture a large part of this traffic without difficulty. As regards the remainder, approximately two-thirds of their trade, which would be left to the shipping companies, the rough cargo would no doubt continue to go by sea, but perishable and finer classes of goods at present shipped from the nearer Channel ports would probably be sent by the Tunnel route. The shipping companies, however, depend on the more valuable classes of goods, which pay higher rates, to balance the low rates on rough cargo. The evidence placed before us shows that nearly one-third of the inward traffic, and nearly one-quarter of the total traffic, inward and outward, carried by the shipping lines, is carried at the higher rates. If, therefore, this traffic, or a large part of it, were lost, they would be left with only an unremunerative fraction of their trade. There would no doubt be some diversion to a Channel Tunnel from the shipping companies of goods at present shipped to and from the more distant Continental ports; but experience alone will show to what extent this would take place. As regards the nearer Continental ports, it is probable that a large part of the traffic at present carried by the shipping companies would be secured by a Tunnel. In general, the shipping companies took the view that the question whether the Channel Tunnel scheme is to go forward should be determined on considerations of the national interest, but that, as it would benefit the railways with which they compete, adequate safeguards should be provided to protect their interests. It is not possible for us to anticipate the nature of those safeguards, but it may be that a solution would be found in the extension of the arrangements which we understand have been adopted in the past in rush seasons, whereby traffic is allocated by agreement between the railways and the shipping companies.

(e.) Railways.

(i.) *The Southern Railway.*

125. We turn now to the effect which a Channel Tunnel would have on railway undertakings in this country. The Company most affected is the Southern Railway, the active co-operation of which would be essential to the Tunnel scheme. It has been represented to us on behalf of the Company—and is no doubt the case—that the building of a Channel Tunnel has not at the present time the same financial attractions to the Southern Railway Company as it had to their predecessors, the London, Chatham and Dover and South-Eastern Railway Companies, when the evidence was given on behalf of those Companies before the Select Committee in 1883. This is, no doubt, due in part to the fact that both the Havre and Dieppe routes were at that time in direct competition with the routes provided by the South-Eastern and London, Chatham and Dover Companies, and that

those Companies expected to attract the bulk of this traffic to the Tunnel route. To-day, however, owing to the amalgamation of the railways, this competition no longer exists so far as the English railways are concerned. The general attitude of the Company, as disclosed in the evidence laid before us, is one of caution, though we were assured that, if it were ultimately decided to proceed with the Tunnel scheme, the Company would do all in their power to ensure its success. We have already dealt with the views of the Company regarding the cost of the scheme (paragraph 61) and the probable volume of passenger traffic (paragraph 68) and goods traffic (paragraph 95). As regards the cost, the estimate of the Company is substantially the same as that prepared for us by the Consulting Engineers. As regards the passenger traffic, the Company's estimate of its probable volume is less than that which we ourselves have prepared. This is due to their assuming a lower rate of progression for the period that must elapse before a Tunnel could be opened, a smaller amount of diversion from other routes and a smaller amount of new traffic especially attracted to the Tunnel route on account of the facilities offered. Their estimate of probable goods traffic is also, we think, likely to be exceeded. We have explained (paragraph 46) that the present proposals contemplate an arrangement between the Southern Railway, the Chemin de Fer du Nord and the British and French Channel Tunnel Companies whereby the first two named companies would operate and maintain the Tunnel. From the financial point of view, the attractions of the Tunnel to the Southern Railway must largely depend on the terms of that agreement. We understand that no agreement has at present been negotiated, and we are therefore not in a position to offer any observations on this aspect of the question. The Southern Railway have informed us that, in the event of a Channel Tunnel being constructed, they would propose to discontinue the present passenger boat services on the Dover–Calais and Folkestone –Boulogne routes, and possibly to curtail or discontinue services on certain other routes. In that event, the Company would clearly have to take into account the possible loss on the capital invested in the boats operating on these services and also the loss of the profits now earned by these services. In 1928, this profit amounted to £437,000. There was also a profit of about £60,000 on the Newhaven–Dieppe service during last year. The Company anticipate that this latter figure would be reduced owing to the transference of some of the passengers from that route to the Channel Tunnel. The Company also draw attention to the capital, estimated roughly at £1,500,000, which they have spent on the marine stations at Dover and Folkestone and the approaches thereto, which would, to a large extent, be rendered unproductive if a Channel Tunnel were constructed. The Southern Railway Company guarantee interest at the rate of $3\frac{3}{4}$ per cent. on £1,000,000 of Redeemable Debenture Stock raised by the Dover Harbour Board to meet the cost of harbour improvements. The interest on this amount is at present entirely covered

by a poll tax on passengers embarking and disembarking at Dover.* If a Channel Tunnel were built, this source of revenue would disappear, and the Railway Company would be called upon to meet their liability under this guarantee. In addition to the foregoing, there is the capital expenditure which they would have to incur to accommodate their system to the use of a Channel Tunnel. The nature of this expenditure, which the Company estimate at approximately £3,000,000, is discussed in paragraph 50 of our Report.

126. To sum up the views of the Company on this aspect of the question, a direct loss is anticipated, immediately upon the opening of the Tunnel, of about £500,000 per annum, to which must be added the interest charges on, say, £3,000,000 of new capital which the Company consider will require to be expended on consequential works. The question whether, in these circumstances, a Channel Tunnel would be advantageous to the Southern Railway depends partly on the success of the Tunnel and partly on the terms which the Southern Railway, in conjunction with the Chemin de Fer du Nord, are able to make with the British and French Channel Tunnel Companies.

(ii.) *The London and North-Eastern Railway.*

127. The other British railway company that might be considerably affected by the construction of a Channel Tunnel is the London and North-Eastern Railway. The witness who appeared before us on behalf of the Company expressed the view that the opening of a Channel Tunnel would have the effect of diverting to the Tunnel route a large volume of traffic at present passing by other routes in addition to that passing by the Dover–Calais or Folkestone–Boulogne routes. This is a question of time, fare and convenience. The diversion to the Tunnel route due solely to the acceleration of the service would be small apart from that caused by the provision of additional through trains. Convenience would, however, be an important factor in diverting traffic from existing routes. It may be assumed that night expresses would be a feature of the services by a Channel Tunnel, and that these would provide sleeping accommodation of the best and most up-to-date description suited for all classes of passengers. These would enable passengers to leave London for night transit to Continental destinations without the necessity of any transfer *en route*, and would thus deprive the long sea routes, such as those viâ Harwich, of an advantage which they at present possess over the short sea routes which, from their nature, are

*Note.—The fare charged for the Cross-Channel journey includes a sum to cover poll taxes imposed as a contribution towards the maintenance of the British and French ports used for the boat service. These poll taxes would presumably no longer be payable, and the future disposal of the portion of the fare at present reserved for their payment would be a matter for negotiation between the Southern Railway, the Chemin de Fer du Nord and the Channel Tunnel Companies.

inconvenient for a night service. In the opinion of the Company, development of this kind would have more effect on the diversion of traffic than any mere reduction in time of transit.

128. On a reasonable assumption as to the convenience of the train service provided viâ the Channel Tunnel, both as to through facilities, restaurant and sleeping accommodation, the Company anticipate that the diversion from the Harwich route to the Channel Tunnel route would be approximately as follows :—

Holland	Nil.
Belgium	10 per cent.
Germany, Switzerland, &c. ...	50 per cent.

In round numbers this diversion would mean a loss to the Port of Harwich of about 70,000 passengers per annum (including 19,000 through Harwich/Flushing). The effect of the foregoing would be to divert from the Harwich routes something between 20 and 25 per cent. of the existing traffic, and the loss in revenue —estimated at £130,000 per annum, sea and rail—could not be made good in normal conditions by saving in operating expenditure. The savings would probably be limited to a diminution in the number of extra sailings during the height of the season. On account of mails and parcels the Harwich routes earn a revenue of approximately £90,000 per annum. This traffic is exceptionally affected by considerations of speed and unbroken transit—both considerations specially favourable to the Channel Tunnel route. The Company anticipate that the diversion of mails and parcels would amount to at least 25 per cent.—say, £22,500 gross. Allowing for a saving in expenses of handling, the net loss under this head may be put at £20,000 per annum. They estimate the probable loss to the catering and hotels department of the Railway Company roughly at a net figure of £5,000 per annum. As regards good traffic, the Company anticipate that, so far as concerns goods consigned to London, the Tunnel route would divert large quantities of perishable goods from existing steamship routes, but it would not, in their opinion, be likely to divert any considerable part of the general merchandise at present carried by the Shipping Companies on the short sea routes. They consider that in such a contest the balance of advantage would be on the side of the Shipping Companies, and support this view by reference to their experience with the Harwich train ferry. The latter, as far as goods are concerned, provides almost the same facility as a Tunnel, traffic passing from the point of origin to the point of destination without any break of bulk. It has not, however, diverted from ordinary steamer routes any traffic other than those special and limited classes for which through conveyance without transhipment is the prime consideration. The Company estimate that a diversion from the Harwich routes to the extent of about 10,000 tons might be anticipated, with an approximate annual loss, taking both sea and rail conveyance into account, of £15,000

gross, or, say, £10,000 net. As regards provincial goods traffic, *i.e.*, that to and from stations north of London, they do not apprehend that any appreciable transfer of business to the Tunnel route would take place.

129. From the foregoing estimates it will be seen that the Company estimate the total net loss to their undertaking from diversion of traffic to the Channel Tunnel route at £165,000 per annum, of which approximately £120,000 would fall upon the shipping as distinct from the rail service. The total profit realised from the Harwich shipping services during the year 1928 was £184,000. The estimated diversion, if realised, would, therefore, wipe out approximately two-thirds of the profits now realised, with a corresponding loss in respect of rail receipts. Turning to the question of the capital expended on the development of their services, the Company point out that they have ordered three new steamers with much increased passenger accommodation. One of these is already in the service, and the other two will be ready in the early months of this year. The cost of the vessels is very heavy (£700,000), and their earning power would obviously be seriously restricted if a Channel Tunnel should be constructed and should divert business as anticipated. Further, to deal with the expansion of the Company's own Continental traffic, and to afford accommodation for other steamship services, an extension of Parkeston Quay (Harwich), with the provision of additional up-to-date appliances, is under immediate consideration. A decision to construct a Channel Tunnel would tell very heavily against any proposal for this extension at Parkeston Quay, and would certainly give to such expenditure a much more speculative character. We understand that the Company's decision in regard to the proposed Parkeston extension is likely to be deferred until it is known whether or not the Channel Tunnel scheme is to go forward. In general, we understand that the attitude to be adopted towards the Channel Tunnel proposal has not been the subject of any definite decision on the part of the Board of the London and North-Eastern Railway. Evidently, this must depend on the nature of the proposal put forward. If the Channel Tunnel is to be constructed as a commercial proposition, without financial or other aid from public authorities in this country or in France, a competing railway would have difficulty in putting forward any special claims for consideration or compensation. As a competing concern, the Railway Company would no doubt be afforded an opportunity of presenting its case before a Parliamentary Committee, according to the customary procedure. The position would be entirely altered if financial or other substantial assistance was given by the English or French Government, or by public authorities of any kind. In that event, the Company consider that they would be entitled to make a claim for reasonable compensation. The London and North-Eastern Railway Company (or its predecessor in title) has, at its own cost, and

without Government assistance of any kind, established steamship services for the benefit of Continental travel; it has expended a large capital in providing the necessary ships and berthing accommodation, with the necessary cranes, warehouses and railway station; it has provided specially luxurious trains for the conveyance of Continental passengers, together with hotels at Parkeston Quay and Liverpool Street, wholly or largely for their accommodation. It would, in their view, be manifestly inequitable that they should be deprived of two-thirds of the narrow profit which they are at last realising on this investment by the intervention of a public authority in support of a competing route, which could never have been brought into being without that intervention.

(iii.) *The London, Midland and Scottish Railway and the Great Western Railway.*

130. The London, Midland and Scottish Railway Company state that a Channel Tunnel would adversely affect the volume of passenger traffic carried on their Tilbury–Dunkirk service. They think that the number of passengers diverted to the Tunnel route would be roughly equivalent to the difference between the number of passengers carried at present and 200,000, to which figure they anticipate the traffic will have grown in 1936. In other words, a Tunnel would have the effect of reducing the passenger traffic at that date to a figure equal to the present number of passengers. At the same time they consider that the increased number of visitors from the Continent viâ the Channel Tunnel would more than counterbalance this loss of revenue by bringing about increased passenger business in other directions. With regard to merchandise carried at passenger train rates, practically the whole of this traffic would be diverted to the Tunnel route, but here again there might be increased business between provincial towns and the Continent.

131. The Great Western Railway, whom we also consulted, replied that they had no special points which they desired to bring to our attention.

(f.) Conclusions.

132. In the foregoing paragraphs we have described the steps that we have taken to ascertain the views of the various interests that are likely to be affected by a Channel Tunnel. We have shown that, especially in the south and east of England, the farming community are apprehensive of the effect which a Tunnel would have on their industry. We have examined the various classes of agricultural produce that might be imported by a Channel Tunnel, and our general conclusion (paragraph 116) is that, in the case of special classes (particularly grapes, cucumbers and flowers), there would be some increase of foreign competition on the opening of a Tunnel. In our view, however, closer

proximity to their market should continue to enable the British producer to bring his crop to London more rapidly and in better condition than is possible for his foreign rival, especially if there were an improvement in the existing methods of marketing the produce grown. The bodies representing industry and trade whom we have consulted have in the main been reluctant to commit themselves to any definite view on the effect of a Channel Tunnel. Subject to a reservation on its possible adverse effect on trade, Chambers of Commerce are, on general grounds, in favour of its construction, but manufacturers are apprehensive that it might stimulate the import of foreign goods to the detriment of their own production. As regards shipping, the companies engaged in running cargo boats on the cross-Channel short sea trades are alarmed at the prospect of a Channel Tunnel which, they consider, would be able, with the aid of through rates, to secure a large part of their present business, and would, in any case, be sure of obtaining a considerable part of the perishable and high-paying traffic. If it were decided to proceed with the Channel Tunnel scheme, it would be necessary for careful consideration to be given not only to its effect on these Companies, but to the danger that, if they were driven out of business, freights might tend to rise owing to the disappearance of their competition. Turning to the railways, the Southern is in a special position, as its active co-operation is essential to the Tunnel scheme. Such co-operation would naturally only be forthcoming if the company considered that the terms they could obtain from the Channel Tunnel Company were sufficiently attractive. The London and North-Eastern Railway fear that part of their Continental business might be diverted to a Tunnel. The London, Midland and Scottish Railway entertain the same view as regards their Tilbury–Dunkirk service, but consider that losses on that account would be more than off-set by general growth of traffic following on the opening of a Tunnel.

133. We have also examined the tunnel scheme from the point of view of the amount of employment that it would give and of the amount of labour that it might displace. As regards the former, it appears that the construction of the British portion of the pilot tunnel would probably give direct employment to an average of 250 men per annum for five years while the pilot tunnel was being built, and that in the following three-year period, when the main tunnels were under construction, approximately 1,550 men would be directly employed. For the same periods, the estimated number of men to whom employment would be indirectly afforded is estimated at 750 and 4,500 respectively.* As regards the displacement of labour on the opening of a Channel Tunnel, it is probable that reductions amounting to about 1,000 men

* NOTE.—These figures are rather lower than might have been expected, having regard to the heavy estimated cost of the scheme. We understand that this is due to the fact that the Estimate prepared by the Consulting Engineers not only provides for the payment of interest during construction, but includes large sums for standing charges, supervision, engineering, &c., and contingencies.

would be made by the Southern Railway. In addition, there are some 2,000 men engaged in the Short Sea shipping trade, some of whom might also lose their employment. It appears, therefore, that the additional employment likely to be afforded, directly or indirectly, by the tunnel during construction is not very large. No question of displacement of labour would arise until the Tunnel was actually opened. When it occurred, it would also probably not be very considerable.

134. In considering the wider aspects of the problem, it is important to bear in mind that the Tunnel scheme is essentially a proposal designed to secure a larger passenger movement between this country and the Continent and *vice versa*. The movement of merchandise at present shipped to and from the Continent on the cross-Channel short-sea routes is comparatively unimportant in relation to the trade of the country as a whole, and largely consists of perishable goods or goods of relatively high value. In fact, the value of goods imported, exported and re-exported in recent years by the Dover, Folkestone and Newhaven routes has amounted to less than 3 per cent. of the foreign trade of this country. The trades and industries upon which the advantages claimed for a Channel Tunnel (*i.e.*, greater facilities, greater speed and the avoidance of handling at the Channel ports) would be likely to react directly in one way or another are few and unimportant in relation to the total trade of this country if the character of the goods shipped remained as at present. The advantages or disadvantages, on the other hand, which an increase of passenger traffic is likely to produce are almost impossible to trace to any particular industry or locality. It is not surprising therefore that the representatives of trade and industry of the country as a whole should be reluctant to express a view on the economic value of a Tunnel to themselves. But, even if the economic reactions upon individual industries were more obvious, it would, in our view, be hazardous to attempt to determine the economic value to this country of a Channel Tunnel by weighing the advantages which might accrue to one set of industries against the disadvantages to others. It would be extremely difficult to place relative values on the extent to which this or that industry would be affected, if the assessment was to be made merely in the light of present-day conditions. But when, as is the case, these determinations have to be made in regard to conditions not of the present day but of a period ten years or more distant, the impracticability of such a line of approach becomes even more evident. Trade and industry and the conditions surrounding them, both in this country and abroad, do not stand still. They are subject to constant change and evolution, the trend and result of which at so distant a date no one will be bold enough to forecast.

135. In seeking views of representative trades and industries, we did not look to find an answer to the question whether the advantages or disadvantages of a Channel Tunnel are the greater. We hoped rather to ascertain the importance, in relation to the

general internal economy of this country, of the individual trades and industries which, in the light of present-day conditions, expect to be directly affected by the existence of a Channel Tunnel. In the result, it appears that the trades that may be adversely affected, though important in themselves, are not numerous and represent only a small section of the trades and industries of this country taken as a whole.

136. This part of our inquiry would, however, be incomplete if we did not seek to examine the problem before us from a wider angle. The history of the last century abounds with examples of innovations in methods of transport far more important than those which would result from a Channel Tunnel. We think it fair to assume that the experience of the past may in such a matter afford valuable evidence of what may be expected to happen in the future. Major improvements in transport, when first proposed, were regarded with deep suspicion and alarming prophecies were made regarding their effect on established industries. Taken together, these improvements have, during the last eighty years, revolutionised all forms of communication, and the period as a whole was characterised, not by losses due to their introduction, but rather by general economic progress unequalled in previous experience.

137. Great innovations it is true, whether in industry or in methods of transport, have not only brought development and increased prosperity, but have also borne heavily on the industries that they have supplanted. The period of adjustment has often been painful and has been accompanied by hardship for those formerly engaged in the methods or processes displaced by progress. The question before us is whether, from the point of view of the country as a whole, the benefits which a Channel Tunnel would bring would more than counter-balance the inevitable hardships which in the initial period would follow in its train. On the whole, after weighing all the evidence, we are of the opinion that the advantages that would accrue to this country from a Channel Tunnel would be likely to increase with the passage of years. The hardships that it would cause would, we believe, be temporary in character and relatively slight in extent. From the evidence received, there is every reason to hope that they would be far less than those which in the past have marked the introduction of other material changes in the economic life of the country. We conclude therefore on balance that, if, as we believe, a Channel Tunnel could be built, maintained and operated by private enterprise at a cost which would permit of the traffic through it being conveyed at rates no higher than those at present in force on the short cross-Channel route, its construction, by creating new traffic and thus increasing trade, would be of economic advantage to this country.

138. We recognise that the Government of any country has the power to modify or impede the working of trade routes through its territory by means of fiscal tariffs. Whether such action would be taken in the case of the Channel Tunnel route, it is, of course,

impossible to say. In the foregoing survey of the economic effects of a Channel Tunnel on this country we have therefore assumed that no discriminatory tariffs would be directed against the Tunnel and that from this point of view the conditions in which it would be operated would be substantially the same as those which now obtain between this country and the continent.

139. It remains to examine what the return on the capital is likely to be. Taking the figures submitted to us by the Consulting Engineers in their estimate of the cost of constructing, equipping, maintaining and operating the Channel Tunnel, and assuming that the rates of charges for the conveyance of passengers and goods would not exceed those at present in force, and that the passenger traffic in the first year of its operation would be that estimated by us (paragraph 86), with due allowance for mail and merchandise traffic, our calculations indicate that the return on the capital invested, though probably meagre in the early years, should increase steadily if—as may with some confidence be expected—the passenger traffic continues to expand at the same average compound rate as that at which it has expanded since 1850, viz., 4 per cent. per annum. In submitting these conclusions, we desire to emphasise, however, that they can only be expected to be realised if no major physical difficulties are encountered in the construction of the Tunnel, and if the estimates submitted to us are not, for other reasons, exceeded to any material extent. We wish, further, to emphasise that the expenditure involved in the exploratory work of driving the pilot and drainage tunnels must, of necessity, be highly speculative. Whether the risks involved are commensurate with, or disproportionate to, the financial reward likely to accrue to those embarking on the enterprise is largely a matter of personal feeling, and is an aspect of the problem upon which we do not feel called upon to express an opinion.

VIII.—MISCELLANEOUS CONSIDERATIONS.

(a.) Questions of sovereignty and jurisdiction that would require to be settled between the British and French Governments.

140. We assume that if His Majesty's Government decide to lift the ban imposed in 1883 on the construction of a Channel Tunnel, they will at once open conversations with the French Government on the important legal and administrative questions which would require to be settled before the British and French Channel Tunnel Companies could start operations. The procedure which would probably be found most suitable would be the appointment, as in 1876, of a joint Anglo-French Commission charged with the duty of preparing a draft Treaty or Agreement for the consideration of the two Governments (see paragraph 19).

141. In the course of our Inquiry, our attention has been drawn to a number of the points on which such agreement would be required. We have not felt called upon ourselves to consider these questions, which indeed fall outside the scope of our terms of reference. We think, however, that it may be convenient at this point to indicate briefly the more important. The first question to be settled would be that relating to sovereignty in respect of the portion of the Tunnel lying outside the three-mile limits of England and France respectively. We are advised that the subsoil beneath the sea is a *res nullius* and is therefore like any other *res nullius*, or unoccupied territory, capable of being acquired by effective occupation. The point in the Tunnel at which British sovereignty would end and French sovereignty would begin could therefore be settled without difficulty by a Treaty between this country and France. The settlement of this question would determine at what point in the Tunnel the jurisdiction of the British Government would end and that of the French Government would begin. The treaty would, also, need to provide measures for determining, as regards any given offence alleged to have been committed in the Tunnel, whether it was committed in the portion under British jurisdiction or in that under French jurisdiction. Suitable arrangements would also have to be made by the two Governments for the apprehension of persons charged with having committed offences either in the Tunnel or in trains that had passed through it; for the attendance of witnesses at the trial of such persons and for similar purposes. Arrangements would also be required to define the procedure to be followed in civil actions arising out of incidents occurring in the Tunnel and also to determine the liability of the operating Railway Companies in the case of accidents to passengers, theft of mails or baggage, &c. Other administrative matters requiring agreement would be those relating to the customs, police and postal services.

142. Another important series of provisions in any treaty regulating a Channel Tunnel would be those defining the conditions in which the Government of either country would be entitled temporarily to suspend the use of the Tunnel, the conditions on which compensation would be payable by a Government exercising its right under this section and the classes of persons by whom such compensation, if any, might be claimed. Each Government would, no doubt, desire to ensure that in all circumstances it maintained effective control over the part of the Tunnel within its territory, and it might be found more satisfactory to embody the provisions to this end in the proposed Treaty rather than in the concession to be granted to the Tunnel Company concerned or in the private legislation which, as in this country, such a Company would have to promote.

143. Finally, it might be considered desirable to include in the Treaty provision for the appointment of a joint body nominated by the two Governments charged with appropriate duties of inspection during the construction of the Tunnel and, possibly, of supervision of its subsequent maintenance.

(b.) Cost of measures required for the defence of a Channel Tunnel.

144. We are expressly confined by our terms of reference to the consideration of the economic aspects of the proposals for a Channel Tunnel, and we have therefore given no consideration to the question of the defensive measures that might be required to protect the British end of the Tunnel or of the preliminary steps that would be necessary to ensure the effective blocking of the Tunnel, should such ever be considered necessary in the national interest. Equally we are of necessity without information regarding the cost of such measures, as no estimate of any value could have been furnished to us without the whole question being reviewed by the competent authorities in the light of existing conditions. There is, however, one point connected with this question on which we think it proper to offer our views. The suggestion was made to us in evidence that, as the military liabilities of the country would be increased by the construction of a Tunnel, it would be reasonable for His Majesty's Government to require the Channel Tunnel Company to bear, in whole or in part, the cost of such additional defensive measures as might be deemed necessary in connection with the Tunnel. On this we would observe that it would, in our view, be inequitable to seek to impose on a commercial concern financial liability for such defensive measures as may be deemed necessary for the protection, not merely or primarily of the interests of that individual concern, but of the general community of which it forms a part. There is, we believe, no precedent for such a charge, though in many instances the construction of large works by private enterprise must in fact have thrown added responsibilities on the defensive forces of the country.

(c.) Miscellaneous questions affecting the finance of the scheme.

145. In the course of our Inquiry our attention has been drawn to a number of points regarding the financing of the proposed undertaking on which we desire to offer the following observations :—

(i.) *Financial Assistance by Government.*

146. Some witnesses referred to the possibility that in certain circumstances the Government might be asked to afford some special form of financial assistance to the scheme, either by guarantee or otherwise. We consider that on economic grounds generally if a Channel Tunnel is constructed, the work should be carried out by private enterprise and should not be accorded any special financial assistance by Government. On this point we were much impressed by the view put before us on behalf of the London and North Eastern Railway Company (paragraph 129). That Company (or its predecessor in title), has, at its own cost,

and without Government assistance of any kind, established steamship services for the benefit of Continental travel; it has expended a large capital in providing the ships and berthing accommodation, with the necessary cranes, warehouses and railway station; it has provided specially luxurious trains for the conveyance of Continental passengers, together with hotels at Parkeston Quay and Liverpool Street, wholly or largely for their accommodation. The Company consider that, if special assistance was given by the Government to the Channel Tunnel scheme, they would be entitled to make a claim for reasonable compensation, as it would be in their view inequitable that they should be deprived of two-thirds of the narrow profit which they are realising on this investment by the intervention of a public authority in support of a competing route. Other competing concerns have also incurred expenditure in the development of their services without Government aid and would be similarly prejudiced if any special financial assistance was given to this scheme. For these and also for more general reasons we are opposed on economic grounds to the grant of such assistance.

(ii.) *Financial Liaison between British and French Channel Tunnel Companies.*

147. It will be seen (paragraph 47) that in the form put before us the scheme contemplates that the British and French Channel Tunnel Companies should each assume complete financial responsibility for the construction of their respective sectors of the Tunnel. At the present stage no other scheme could probably have been put forward. We doubt, however, whether in the event of permission being given for the construction of a Tunnel, either Company would in fact desire such an arrangement. The construction of the British and French sectors of the Tunnel are merely parts of a single operation, and the success of either Company is closely bound up with that of the other. If, for example, one Company were forced by insuperable obstacles to abandon their undertaking, the whole of the expenditure incurred by the other Company would become nugatory. We do not question that it is desirable that the British sector should be constructed under British direction and the French sector under French direction. We are, however, of opinion that some arrangement should be made between the two constructing Companies for sharing financial responsibility for the construction of their respective sectors.

(iii.) *Subscription of Capital required.*

148. It has been generally assumed that as regards the provision of capital, that needed by the British Channel Tunnel Company would be subscribed in this country and that needed by the French Channel Tunnel Company would be subscribed in France. On general grounds, we should prefer to see the share

capital of the British Channel Tunnel Company subscribed and held in this country. In practice, a stipulation of that kind is, however, almost impossible to enforce, and in the special circumstances of the present scheme we do not consider that it need be regarded as essential. We have shown (paragraph 142) that for military and other public reasons, the provision in the national interest of effective safeguards for Government supervision of the British sector of the Tunnel would be an essential condition to the grant of permission for its construction. The existence of such safeguards would, in our view, be adequate, even if some of the capital stock were owned outside this country.

(d.) Diseases of animals and plants.

149. It has been suggested to us that if a Channel Tunnel were constructed, there would be an increased risk of animal and plant diseases being introduced in this country. The suggestion is that there would be a greater risk of infection owing to the running of through goods waggons than there is under the present system by which goods are transferred at the ports from rail to ship. We think that this danger can easily be overestimated, since (see paragraph 51) from the evidence of the Railway Companies, it appears that miscellaneous goods despatched by the Tunnel route would in any case be transferred at the ports to the special Tunnel service goods waggons. The only through goods waggons that are likely to be employed are those constructed to serve the needs of particular districts in France and elsewhere, where local goods traffic for the Tunnel route is sufficiently large to enable bulk consignments to be made. From this point of view the principal change that would be brought about by the construction of a Tunnel would be that certain classes of goods hitherto imported into this country by ship would in future be imported by train. The nature of the administrative arrangements for inspection and control would, no doubt, require revision and perhaps elaboration. Dangers from this source undoubtedly exist at the present time, but we see little reason to believe that any increased risk resulting from a Channel Tunnel could not be adequately dealt with.

(e.) Possible Social and Other Indirect Effects of a Channel Tunnel.

150. Two witnesses appeared before us who were opposed to the construction of a Channel Tunnel on other than economic or military grounds. These witnesses objected to the scheme on the ground that a Tunnel would in fact create a land frontier between this country and the Continent. They felt that the fact that Great Britain was an island had been of great value in the past. They believed that if it ceased to be an island, as it would if a Tunnel were constructed, there was a risk of undesirable reactions of a social and moral kind. Such questions are outside our terms of reference, but we think it proper to place on record

this brief reference to the views on this subject placed before us, which we do not doubt will be considered at a later date by His Majesty's Government.

IX.—GENERAL SURVEY OF EVIDENCE RECEIVED.

151. We summarise in the following paragraphs the principal points that have emerged from the evidence that we have received and our conclusions thereon.

CHANNEL FERRIES AND OTHER NEW METHODS OF CROSS-CHANNEL COMMUNICATION PROPOSED AS ALTERNATIVES TO A CHANNEL TUNNEL.

152. By our Terms of Reference we are directed to consider not only proposals for a Channel Tunnel but those for other new means of cross-Channel communication (paragraphs 27–42). Of the latter, the only one which in our view is practicable on financial and technical grounds is that for a Channel Ferry. We are, however, satisfied that the Dover–Calais and Folkestone–Boulogne routes are unsuitable for a passenger ferry service. We base this view mainly on the following considerations:—

(i.) For these routes it would be necessary to employ boats of shallow draught and therefore of relatively small size. From the point of view of passengers who object to a sea passage in rough weather, such a ferry would offer few, if any, advantages over the existing Channel boats.

(ii.) The relatively small size of the ferry boats would make it necessary to split the trains. There would, therefore, be little or no saving of time in the cross-Channel journey by train ferry as compared with the existing services (paragraphs 27–37).

ALTERNATIVE PROPOSALS FOR A CHANNEL TUNNEL.

153. Of the proposals for a Channel Tunnel, the only one that merits serious consideration is that put forward by the Channel Tunnel Company, the particulars of which have been worked out in collaboration with the Southern Railway and the Chemin de Fer du Nord (paragraphs 44–45).

THE CHANNEL TUNNEL COMPANY'S PROPOSALS.

154. The Channel Tunnel Company propose that the tunnelling to be undertaken should consist of (a) two independent traffic tunnels, each with a diameter of 18 feet 6 inches, and (b) of a smaller pilot tunnel, having a diameter of 10 feet, for drainage and ventilation purposes. Under this scheme the whole of the tunnel section

linking the Southern Railway and the Chemin de Fer du Nord would be electrically operated, and for this purpose it would be necessary to construct exchange stations at each end of the tunnel. It is anticipated that the open approaches from the mouth of the Tunnel to the exchange station on the English side (which would be at Sandling Junction) would be 3 miles and 20 chains in length and that the length of those on the French side would be 5 miles and 30 chains (paragraph 46).

The cost of the exchange stations and of any consequential improvements that might be required in the existing railway lines to the English and French coasts would be met by the Southern Railway and the Chemin de Fer du Nord respectively. The latter Companies would also share the cost of the new steel rolling-stock required. The Channel Tunnel Companies would not themselves maintain or operate the tunnel section, but would enter into agreements for these services to be carried out by the two Railway Companies, who would be in a position to do so at a substantially lower cost (paragraph 46).

The foregoing proposals assume that the rolling-stock using the tunnel will conform to the British loading gauge. In previous schemes it was believed that the Continental railways would insist on the adoption of their larger loading gauge. This would have involved very heavy expenditure, estimated by the Southern Railway at £10,000,000, in the adaptation of their system from the coast to London. There is, however, reason now to believe that the French and other Continental Railways affected would accept rolling-stock built to the British loading gauge and would construct a given number of such vehicles for use on the Tunnel service. The total consequential expenditure that would require to be incurred by the Southern Railway is now estimated by that Company at approximately £3,000,000 (paragraphs 48–51).

GEOLOGICAL EVIDENCE AVAILABLE.

155. The geological data available fall into three classes, namely, that afforded by the beds of chalk showing on the cliffs on each side of the Channel, by the corresponding beds disclosed by shafts and headings which have been driven on the English and French coasts, and by the soundings in the Channel and surface samples obtained from its bed by the French geologists in 1875 (paragraph 53).

The geological evidence shows clearly that if a tunnel is to be constructed, it must be driven on a line below the water-bearing strata of the upper and middle chalk and that equally it must be on some line above the gault, which overlies the lower greensand, which has as much, if not more, water than the upper chalk. It follows, therefore, that the only formation in which the construction of a tunnel could be attempted with any hope of success is the lower chalk (paragraph 53).

GEOLOGICAL FORMATION SUITABLE FOR A CHANNEL TUNNEL.

156. From the geological point of view the practicability of a Channel Tunnel depends on the continuity under the Channel of the lower chalk. The evidence available points generally to the conclusion that this formation does extend uninterruptedly across the Straits. There is, however, an undoubted risk that fissures or even infilled valleys may be encountered (paragraph 53).

POSSIBILITY OF FISSURES OR INFILLED VALLEYS.

157. If fissures, filled with rough gravel, and therefore affording fairly free passage for the sea water, were met with, cementation would probably seal them up, but if close sand were met with, which yielded large quantities of water, the conditions would be more difficult, and the success of the process doubtful. With the development of engineering resources, fissures, unless of exceptional size, would not, in the view of the Consulting Engineers, present any insuperable difficulty (paragraph 54).

As regards the possibility of meeting an infilled valley charged with water at a pressure of, say, 150 lbs. per square inch, the position would, in the opinion of the Consulting Engineers, be very serious, but even in that event they hesitate to say that the project would have to be abandoned, as it might be possible to deal with it by adopting a shield with an entirely closed face, the excavation being removed by powerful water jets and washed through controlled pipes in the bulkhead (paragraph 54).

PRELIMINARY GEOLOGICAL INVESTIGATIONS REQUIRED.

158. The existing evidence regarding the geological formation of the Channel should be supplemented by samples and soundings obtained from the sector about half-way across the Straits from which no samples were obtained in the previous surveys, and by a sufficient number of samples from other parts of the Straits to afford a rough check of the accuracy of the former surveys. We understand that, given good weather, the necessary observations, if carried out by one of His Majesty's Surveying Ships, could be made in the space of one or two months (paragraph 56).

Borings in the bed of the Channel were suggested by some witnesses, but such could not, except at enormous expense, be made at frequent intervals, and even then there would be no certainty that fissures or infilled valleys did not exist between them (paragraph 56).

PILOT AND DRAINAGE TUNNELS.

159. All witnesses agreed that it was essential that a pilot tunnel should be driven through the whole length of the Straits before any

expenditure was incurred on the main traffic tunnels. The Consulting Engineers recommend:—

(i.) That there should be a drainage tunnel having an internal diameter of 7 feet, and that it should slope from the centre of the Channel down to the coast on each side to permit of drainage by gravitation.

(ii.) That a pilot tunnel having an internal diameter of about 12 feet (instead of 10 feet as proposed by the Channel Tunnel Company) should be driven substantially along the line of the proposed traffic tunnels; that, as the pilot tunnel proceeds, advance and radial boreholes should be driven from it to explore the ground ahead and all round it in order to obtain the fullest information regarding the ground through which the main tunnels would subsequently be driven.

(iii.) That the drainage and pilot tunnels should be driven simultaneously, but that the former should be kept in advance (paragraph 59).

The Consulting Engineers consider that the pilot tunnel should become a permanent unit in the Channel Tunnel system, and should not be enlarged to form one of the main traffic tunnels. This tunnel (and the drainage tunnel) would be lined throughout, and if constructed with the diameter recommended, it would provide sufficient width for the temporary railways which would be required during its construction for the disposal of the spoil and subsequently during the construction of the main tunnels. It would also allow sufficient space for the pipes used for ventilation and other purposes during construction (paragraph 59).

PRACTICABILITY OF CONSTRUCTING A CHANNEL TUNNEL.

160. On the available evidence it appears probable that the lower chalk extends uninterruptedly across the Straits and that it would be possible to construct a Tunnel. There must, however, remain an element of doubt regarding the practicability of constructing a Tunnel until the proposed Pilot Tunnel is completed. If that is successfully accomplished in the manner proposed, the practicability of subsequently constructing the traffic tunnels may be regarded as established (paragraph 56).

THE COST OF CONSTRUCTING A CHANNEL TUNNEL

161. At our request, the Consulting Engineers prepared an independent estimate of the cost of constructing a Channel Tunnel. Their estimates are the most detailed that have yet been prepared in connection with this scheme. They agree very closely with those submitted to us by the Channel Tunnel Company and the Southern Railway. The cost of constructing pilot and drainage tunnels, which

would be lined throughout, is estimated by the Consulting Engineers at £5,600,000, spread over a period of 5 years, and that of constructing and equipping the two traffic tunnels at £24,850,000, spread over a period of three years (paragraph 61).

These estimates include the cost of the construction of the works, the disposal of the excavation by specially designed waggons and its dumping into the sea, and the provision of permanent-way, electrical equipment and sub-stations, signalling, &c. It also includes provision for the payment of interest during construction on the capital employed. It excludes the cost of providing the English and French exchange stations, the open approaches from the mouth of the tunnel to the exchange stations, the electrical locomotives, the necessary rolling-stock, the electric generating stations and the land required, which will fall to be met respectively by the Southern Railway and the Chemin de Fer du Nord (paragraph 61).

DISPOSAL OF THE SPOIL.

162 The scheme submitted to us and that recommended by the Consulting Engineers contemplates that the spoil would be disposed of by waggons. Various witnesses have, however, suggested that by the addition of water it might be possible to reduce the excavated material to a slurry capable of being pumped out of the tunnel. The advantages of this method, which has been worked out in great detail by Monsieur Fougerolles, were strongly urged by the witness of the Chemin de Fer du Nord. A trial of this method could, we understand, be carried out at a cost of about £40,000 in the heading driven in under the sea on the French side about the year 1880. In view of the large economies that would be effected if the system could be successfully employed, we consider that if permission is given to construct a Channel Tunnel this suggestion should be carefully considered before any decision was taken to dispose of the spoil in the ordinary way by waggons (paragraph 60).

MAINTENANCE OF A CHANNEL TUNNEL.

163. The Consulting Engineers consider that no difficulty need be apprehended regarding the maintenance of a Channel Tunnel. The tunnel would be lined throughout, and in sections where the ground contained water the joints of the lining would be caulked. Such small leakages as would occur could be dealt with by the water being led to the drainage headings for pumping. Similarly, no serious difficulty is anticipated regarding the maintenance of the permanent way. There is less corrosion of the rails, &c., in a tunnel where the traffic is worked electrically than in the open. The inspection and repair of the tracks would have to be carried out mainly at night, and would require careful organisation for the transport of men and materials. It is for this service that the pilot tunnel would be principally used after the opening of the tunnel (paragraph 63).

OPERATION OF A CHANNEL TUNNEL.

164. As regards the operation of the railway, electric traction and automatic signalling would be adopted. The running of the trains themselves would, in the view of the Consulting Engineers, create sufficient ventilation, which could be regulated by openings into the pilot tunnel. If this proved to be insufficient, it could, they suggest, be supplemented by propeller fans, the pilot tunnel being used to convey air to the running tunnels (paragraph 64).

COST OF MAINTENANCE AND OPERATION OF A CHANNEL TUNNEL.

165. In view of the considerable divergence of opinion expressed by witnesses, we asked the Consulting Engineers specially to consider the probable cost of the operation and upkeep of a Channel Tunnel, and they reported that on the assumption that the electric locomotives and rolling-stock were owned and maintained by the operating Railway Companies, the expenditure thereon would not reach a sum of £500,000 per annum. This figure includes the cost of the electricity required to maintain a ten-minute service, if necessary, at certain times of the day, but does not include the cost of constructing a generating station on the English side, as the Consulting Engineers assume that by the date that a Channel Tunnel could be opened the necessary current could be obtained from the national scheme under the Central Electricity Board (the "Grid") (paragraph 65).

PROBABLE VOLUME OF PASSENGER TRAFFIC AT THE DATE OF THE OPENING OF A TUNNEL AND THE AMOUNT OF THAT TRAFFIC WHICH A TUNNEL MIGHT BE EXPECTED TO SECURE.

The Channel Tunnel Company's Estimate.

166. The Channel Tunnel Company consider that 80 per cent. of the passenger traffic on the short sea routes would be diverted to a Channel Tunnel and 40 per cent. of the traffic on the other routes, and that the facilities offered by a Channel Tunnel would raise the number of foreigners crossing the Channel to the number of British subjects so doing. On this basis, they calculate that if a Channel Tunnel was opened in 1936, it might be expected to secure 3,577,500 passengers (paragraph 67).

The Southern Railway Company's Estimate.

167. The Southern Railway Company assume for the purpose of their argument that a Channel Tunnel could be opened in 1936; that

the whole of the passengers carried by the short sea routes would be diverted to a Channel Tunnel and that on the other routes the diversion would be as follows:—

	Per cent.
Newhaven–Dieppe	23
Southampton–Havre	30
Dover–Ostend	10
Tilbury–Dunkirk	32
Harwich–Hook of Holland Harwich–Flushing Harwich–Antwerp Harwich–Zeebrugge	16

The Company further assume that the facilities offered by a Channel Tunnel would attract additional passenger traffic equivalent in volume to 15 per cent. of the number of passengers carried on the short sea routes. On this basis and assuming that till 1936 the passenger traffic on the short sea routes will increase at the rate of 2½ per cent. per annum simple, the Southern Railway Company estimate that if a Channel Tunnel was opened in that year, it might be expected to secure 1,524,943 passengers (paragraph 68).

The Chemin de Fer du Nord's Estimate.

168. The Chemin de Fer du Nord state in view of past experience they are satisfied that cross-Channel passenger traffic will continue to increase at the rate of 4·11 per cent. per annum compound until 1940, when they calculate that the number of cross-Channel passengers will amount to 3,721,000 per annum. As regards diversion from existing routes, they make the following assumptions:—

	Per cent.
Boulogne–Folkestone Calais–Dover Dunkirk–Tilbury	100
Dieppe–Newhaven Ostend–Dover	75
Le Havre–Southampton Antwerp–Harwich	50
Other routes	30–35*

On these assumptions they estimate the passenger traffic likely to be secured by a Channel Tunnel in 1940 (if first opened in that year) at 3,200,000 (paragraph 72).

*Paragraphs 69–71.

The Committee's Estimate.

169. In view of the divergence of the opinions summarised above, we undertook an independent survey of existing statistics, from which it appears that the total number of persons crossing the Channel by all routes may be expected to increase during the period up to the opening of a Channel Tunnel at 4 per cent. per annum compound, i.e., at the average compound rate at which it has increased in the period 1850–1928 (excluding the years 1914–1923). On this basis, the total traffic would amount to 3,352,000 in 1938, which is assumed for this purpose to be the year in which the Tunnel would be opened (paragraphs 73–79).

As regards diversion of passenger traffic from other routes we think it reasonable to assume that—

(a.) All the passenger traffic carried by the short sea routes would be diverted to a Channel Tunnel;
(b.) As regards the other Southern Railway routes, 75 per cent. of the through traffic and 15 per cent. of the local traffic would be so diverted;
(c.) As regards the London & North Eastern Railway routes operated from Harwich, 50 per cent. of the through traffic and 10 per cent. of the local traffic other than that to Holland (from which no diversion is anticipated) would be so diverted;
(d.) As regards the London, Midland & Scottish Railway Company's service from Tilbury to Dunkirk, 32 per cent. of the traffic would be diverted (paragraph 81).

Further, it is not unreasonable to expect that the facilities offered by a Channel Tunnel might be expected to lead to an increase of passenger traffic equivalent to 20 per cent. of the short sea traffic at that date (paragraphs 82–85).

On the above basis a Channel Tunnel, if opened in 1938, would secure 2,357,000 passengers in that year (paragraph 86).

AIR TRAFFIC.

170. As regards passenger traffic, the London–Paris air services are not likely to be affected adversely by the advent of a Channel Tunnel. These services will no doubt develop considerably during the next ten years, but they are not likely to offer serious competition to a Channel Tunnel. As regards the carriage of goods, air services at present only compete with other forms of transport in special commodities of high value or those commodities for which rapidity of transport is sufficiently important to outweigh the higher cost. Some of the latter traffic might be diverted to a Channel Tunnel. From the point of view of the Tunnel, it is not likely that air competition for goods traffic would prove a serious factor (paragraphs 87–89).

GOODS TRAFFIC.

171. As regards imports, a Tunnel would probably secure a substantial traffic at present rates in view of the greater speed and regularity of its service compared with that of its competitors, though bulky and less profitable traffic would continue to use the sea route. The same factors would operate in the case of exports, though perhaps to a less extent owing to the longer rail-haul in this country. On the Channel routes imports largely exceed exports, and this might well prompt the companies operating the Tunnel to offer specially attractive rates to exporters, more particularly as they would otherwise have to return trucks empty to the Continent. By doing so they would do something to balance their traffic, and would tend to secure freight at present carried by shipping companies (paragraphs 90–95).

EFFECT OF A CHANNEL TUNNEL ON EMPLOYMENT DURING AND AFTER CONSTRUCTION.

172. The Consulting Engineers estimate that the building of the British half of the pilot and drainage tunnels would give direct employment to an average of 250 men per annum, spread over a period of five years. On the completion of this stage, they estimate that for the remaining (three-year) period, when the main traffic tunnels are under construction, direct employment would be given to an average of 1,550 men on the British section of the Tunnel. They further consider that, during the first (five-year) period when the pilot and drainage tunnels were under construction, additional employment would be indirectly afforded to an average of 750 men per annum, and that during the subsequent (three-year) period when the main traffic tunnels were under construction the additional indirect employment afforded would amount to an average of 4,500 men per annum (paragraphs 97–98).

During the construction period existing services, both passenger and goods, would be maintained as at present, and there would be no falling off of direct employment on account of the tunnel. On the opening of the Tunnel large reductions of staff at the Marine stations at Dover and Folkestone would result from a closing of boat services. The Exchange Station at Sandling Junction would, however, require a fairly large staff and would absorb a considerable proportion of the labour displaced at the Marine Stations. The Southern Railway estimate that at Dover there would probably be a reduction of 143 in the dock staff and 37 in the Dover Marine Station staff; and that at Folkestone reductions on a more or less similar scale might be expected. The marine staff on the cross-Channel boats at present numbers 763 officers and men, who would lose their present employment. The Folkestone Harbour Board is owned and operated by the Southern Railway and allowance has been made in the foregoing estimates for such reductions that might be made in its staff. As regards Dover, the Harbour authorities anticipate that a considerable number of men would lose their

employment on the opening of a Channel Tunnel. In addition there is a possibility of further labour being displaced in the cross-Channel Short Sea Trades, if the fears expressed by the Shipping Companies prove to be well-founded (paragraph 99).

EFFECT OF A CHANNEL TUNNEL ON BRITISH AGRICULTURE.

173. Many agricultural products, i.e., cereals, meat, eggs, poultry and most forms of dairy produce, would be little if at all affected by the construction of a Channel Tunnel. As regards cream, the home trade is not likely to be materially affected. Unless the rates charged for the Tunnel route were markedly lower than those at present in force, it would hardly be profitable for foreign producers to export fluid milk to this country, in view of the capital expenditure that would be involved, the cost of longer transport and the small difference between the wholesale price of milk in this country and on the Continent (paragraphs 100–109).

As regards fruit and vegetables, a large part of the imports into this country do not compete directly with home produce. This is due in some cases to a difference in quality between home-grown produce and that imported from abroad. In other cases it is caused by the imported produce coming on the market at a season when the home-grown produce is not and could not be available. There are, however, certain classes of fruit and vegetables which are or can be grown more cheaply abroad in regions that would be benefited by a Channel Tunnel, and which overlap in season with corresponding British produce. Of these, the principal are grapes, cucumbers and flowers. For these special classes of fruit and vegetables, the opening of a Channel Tunnel would probably be followed by some increase of foreign competition. Closer proximity to their market should, however, continue to enable the British producer to bring his crop to London more rapidly and in better condition than is possible for his foreign rival (paragraphs 110–113).

INDUSTRY AND TRADE.

174. The bodies representing industry and trade who have been consulted have in the main been reluctant to commit themselves to any definite view on the effect of a Channel Tunnel. Subject to certain reservations, Chambers of Commerce are, on general grounds, in favour of its construction, but manufacturers are apprehensive that it might stimulate the import of foreign goods to the detriment of their own production (paragraphs 117–119).

SHIPPING.

175. The companies engaged in running cargo boats on the cross-Channel short sea trades are alarmed at the prospect of a Channel Tunnel, which, they consider, would be able, with the aid of through rates, to secure a large part of their present business, and

would, in any case, be sure of obtaining a considerable part of the perishable and high-paying traffic (paragraphs 120–124).

RAILWAYS.

176. As regards the railways, the Southern Railway is in a special position, as its active co-operation is essential to the Tunnel scheme. Such co-operation would naturally only be forthcoming if the company considered that the terms they could obtain from the Channel Tunnel Company were sufficiently attractive. The London and North-Eastern Railway fear that part of their Continental business might be diverted to a Tunnel. The London, Midland and Scottish Railway entertain the same view as regards their Tilbury–Dunkirk service, but consider that losses on that account would be more than off-set by general growth of traffic following on the opening of a Tunnel (paragraphs 125–131).

X.—SUMMARY OF PRINCIPAL CONCLUSIONS.

177. Our main conclusions on the economic aspects of the Channel Tunnel Scheme are set out in paragraphs 132 to 139 of our Report, and we summarise these and the other main conclusions of our Inquiry as follows:—

1. None of the new forms of cross-Channel communication suggested to us can be regarded as a satisfactory alternative to a Channel Tunnel.

2. On the available evidence it appears probable that the geological and engineering difficulties likely to be encountered could be successfully overcome. There must, however, remain an element of doubt regarding the practicability of constructing a tunnel until the proposed pilot tunnel, estimated to cost £5,600,000, has been successfully driven right across the Channel.

3. If the pilot tunnel is successfully constructed in the manner proposed, the practicability of subsequently constructing the traffic tunnels may be regarded as established. The cost of the latter tunnels is estimated at about £25,000,000. There would be no difficulty about their operation and upkeep.

4. If a Channel Tunnel is constructed, we consider that on economic grounds the work should be carried out by private enterprise and should not be accorded any special financial assistance by Government.

5. We believe that a Channel Tunnel could be built, maintained and operated by private enterprise at a cost which would permit of the traffic through it being conveyed at rates not higher than those at present in force on the short cross-Channel route.

6. In the light of conclusion 5 above, we believe that, although some interests would probably be adversely affected, the construction of a Channel Tunnel, by creating new traffic and thus increasing trade, would be of economic advantage to this country.

(Signed) E. R. PEACOCK, *Chairman.*
EBBISHAM.*
CLEMENT D. M. HINDLEY.
FREDERICK W. LEWIS.
HENRY STRAKOSCH.

(Signed) THOMAS JONES, A. F. HEMMING } *Joint Secretaries.*

2, *Whitehall Gardens, S.W.* 1,
February 28, 1930.

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* Subject to the Minute of Dissent attached hereto.

MINUTE OF DISSENT
by
LORD EBBISHAM.

I HAVE signed the Report, subject to the following Minute of Dissent :—

I.—Passenger Traffic.

I do not propose to examine in any detail the complicated figures and tables set out in this section. The fact that it has been possible to arrive at such diverse estimates of the probable growth of this traffic shows clearly the difficulty of the task. I content myself with expressing my conviction that the figures adopted by my colleagues are not likely to be reached, and that the rates of increase chosen are not likely to be attained. However, for the purpose of examining the effect of the Tunnel I will assume that the Tunnel will be such a success in the volume of traffic, both of passengers and goods it will carry, as to afford a reasonable return on the capital outlay involved; on any other assumption there can naturally be no justification for embarking on such a vast expenditure. I therefore propose to deal with the economic aspects of the problem on the hypothesis that the Tunnel will fulfil the expectations indicated, as to passenger traffic in paragraph 86, and as to goods in paragraph 95 of the Report. Apart from any general consideration as to promotion of flow of passenger traffic necessarily resulting to the benefit of trade as a whole—a consideration with which I propose to deal later in another connection—it seems that the greater benefit to be expected is on the assumption that the whole of such additional traffic would consist of foreigners coming into this country and spending money here.

Reference to relative paragraphs in Report.

Paragraphs 66 to 89.

In examining this question it is necessary in the first place to remember that the figure of 305,000 represents journeys and not passengers, therefore the total number of passengers entering or leaving this country as tourists or otherwise is only approximately 150,000. At present, however, three British subjects to one foreigner cross the Channel, and it seems to me unwise to assume that this proportion would be varied in any additional traffic following on the Construction of a Tunnel.

Paragraph 86.

Paragraph 82.

There are two reasons for this view :—

(1.) It seems reasonably clear that the Tunnel would have little effect on the volume of journeys taken for business reasons.

Paragraph 88.

(2.) With regard to tourist traffic, it is alleged that the effect of the Tunnel would be to stimulate tourist traffic from the Continent to this country by removing the present deterrent of the sea crossing.

Paragraph 86.

This must undoubtedly be the case, but in my view the effect is likely to be most limited. The sea crossing is not by any means the only deterrent; the Tunnel itself may prove a deterrent, as travelling in a Tunnel deep under the sea for a distance of 24 miles with no possibility of intermediate exit may prove a distasteful

Reference to relative paragraphs in Report.

Paragraph 86.

prospect for a considerable number of persons. Continental nations have not the same travel habit as ourselves; and it was stated to us by a witness of great experience in such matters that English watering places do not offer the same type of amenity (by reason of licensing restrictions, &c.) as foreign watering places, and would therefore not be likely to attract any substantial increase of continental traffic. This is a factor which must be taken into consideration in estimating the chance of creating any new continental tourist traffic.

Summing up the foregoing, my conclusion is that on the whole the effect of the Tunnel may be to stimulate passenger traffic; though the effect of such stimulus would be slight.

II.—Goods Traffic.

Paragraphs 90 to 95.

I agree with the statement of questions of fact contained in this section, but I cannot accept the conclusions drawn therefrom.

It seems to me that the preponderating advantage will lie with the importer of foreign goods and it must be remembered that the ratio of imports to exports by the Channel routes is to-day as 2 to 1. Therefore any advantage to be gained by the Tunnel will be an advantage in favour of the foreign producer. This view was confirmed by an experienced witness who definitely stated that in his opinion the circumstances of the trade between the Continent and this country are such that a Tunnel must benefit imports more than exports.

It may of course be the case, as suggested, that the added facility will so stimulate exports by this route as to restore the balance of trade, but if this is to be the case then in my view wholly new markets will have to be created.

From Table II of Appendix III it will be seen that the largest classes of exports by the Channel routes are cotton and woollen goods.

With regard to these, speed, lack of handling and the other advantages of through rail transit would have little effect, and I doubt if this class of traffic would be much attracted unless the rates offered were made particularly favourable. If this could be done, it may be that exports would be increased, but the rates would have to be so cut as to be a real assistance to the exporter and to enable him by lowering prices to widen his market. How far this is possible is a matter of speculation; it might well be that to be effective the cut in rates would have to be so great as to make the traffic unremunerative to the Tunnel. Any large increase in trade created by such means to the detriment of either country could always be countered by the imposition of tariffs which would negative any advantage gained by the trades, and by decreasing the volume of traffic would also adversely affect the revenues of the Tunnel. The possibility of tariffs being specially directed against the Tunnel must therefore always constitute a considerable element of risk, not only to the traders, but to the Tunnel itself as a commercial enterprise.

I have thought it right to draw attention to these points; but it must be remembered that the total trade now carried by the cross-Channel short-sea routes amounts to not more than 3 per cent. of the total trade of the country, and therefore any advantage or disadvantage must, on the basis of existing conditions at all events, be comparatively slight. It is possible, however, that if a Channel Tunnel was built, this proportion might be considerably increased, so far as concerns perishable goods.

Reference to relative paragraphs in Report.

III.—Agriculture.

The National Farmers Union have expressed the view that the Tunnel would damage agricultural interests. They are strongly opposed to the project which would in their view intensify the competition from abroad to which agriculture in this country is exposed. They state that in their view it is imperative that the State should refrain from sanctioning any further additions to the handicaps imposed upon the industry. If the State were deliberately to endorse a project which they believe would lead to the intensification of foreign competition, definite injury would in their opinion inevitably accrue at a time when no branch of the industry is in a position to meet such intensified competition.

Paragraphs 100 to 116.

Apart from the foregoing general considerations there are two matters on which I desire to comment:—

1. The first of these is the question of milk and cream dealt with in paragraphs 107 and 114.

Evidence was given to the Committee that a very substantial milk-producing area in Northern France would be brought by the Tunnel much nearer to London in point of time than some of the areas from which London at present draws its milk supply; further, from the evidence, I believe that there would be a possibility of drawing a large supply of milk and cream from the Continent if a Tunnel was constructed. The question is of great importance, as from official statements it appears that of the total produce of farms in Great Britain in 1927-28, Milk and Dairy Produce represented 23·9 per cent. of the whole and was valued at £63,700,000.

Paragraphs 107 and 114.

2. The second point is that dealt with in the latter part of paragraph 115 and in paragraph 116 of the Report, viz., the question of existing arrangements for the transport and marketing of fruit.

Paragraphs 115 and 116.

This question seems to me to be only incidental to the main line of the enquiry; and I personally should desire much fuller information and explanation than has been afforded before adopting the views expressed in those paragraphs.

IV.—Industry and Trade.

The views expressed by Chambers of Commerce are given in paragraph 117.

Paragraphs 117 and 118.

I agree with the general conclusion expressed in paragraph 119 that the result of this part of the inquiry is indecisive, but I think

Reference to relative paragraphs in Report.

weight should be attached to the striking fact that no specific organisation of manufacturers in this country advocates the Tunnel as being of definite assistance to its own industry.

V.—General Conclusions.

There seemed at first sight to be a reasonably strong *primâ facie* case for the Tunnel, but closer acquaintance with the subject has led me to the conclusion that the balance of advantage lies against rather than in favour of the scheme.

The case for the Tunnel rests, as it seems to me, mainly on two arguments :—

Paragraph 134.

(*a*.) That it must promote an increase in the general flow of passenger and goods traffic, with consequent benefit to the community.

Paragraphs 136 and 137.

(*b*.) That the experience of the past teaches that, although the transitional period may be accompanied by hardship, in the end, major improvements in transport are of economic advantage.

As to the first claim, I agree that an increase in the flow of passenger traffic may be expected, though, in my view, as I have attempted to show, it is doubtful how far, in this particular instance, such an increase is calculated to ensure any considerable benefit to this country. Such benefit as there may be cannot be traced to any particular locality or trade, nor is it very apparent what the nature of such benefit may be. In short, this claim should, I think, be regarded more as a hope than an expectation.

With regard to the second head, I doubt if anyone will quarrel with this as a generalisation, though there have been exceptions even to this rule, as, for instance, in the case of canals.

My own difficulty is to fit it in to the particular circumstances of the Tunnel scheme, and to decide how far such a scheme can be classed with the general innovations referred to.

This proposition is based on the experience of great innovations of a general character (such, for instance, as the introduction of steam navigation, railways, or the internal combustion engine), which are equally available for all industries in all countries. The Tunnel would, however, necessarily be largely local in effect, and could react to the advantage or disadvantage of only a small part of the business life of the country.

Further, such innovations have made possible developments of trade and manufacture which, without them, would have been undreamed of. On the other hand, as regards passenger traffic, the Tunnel is a mere replacement of existing facilities, which are capable of ready expansion to meet an increased demand, and are also capable of ready contraction, if such demand should diminish.

As regards goods, it is, I think, worth while to remember that existing facilities are both numerous and flexible, and that they can continue to give adequate service to those industries requiring such service.

The Tunnel, on the other hand, would, if a success, undoubtedly oust most competing facilities from the field, and any accident to it or deliberate suspension of its operation, whether caused by national emergency or sabotage, would, for a time at least, mean partial withdrawal of facilities with consequent disorganisation of trade and expenditure of time and money in devising alternative systems. In other words, the construction of a Tunnel would mean that all or nearly all the eggs would be put in one basket.

Reference to relative paragraphs in Report.

I propose now to summarise the arguments against the scheme :—

(*a*.) We are debarred by our Terms of Reference from considering the military aspects of the question, but unless the strongest evidence of economic advantage is forthcoming, I venture to think that the decision of previous Governments should be maintained.

(*b*.) Definite opposition has been offered by the agricultural and a portion of the shipping industries. There can be no doubt that, in these two cases, a Tunnel would have a detrimental effect. This result is important in that it shows a definite detriment, specifically traceable to particular industries. I do not accept the view stated in paragraph 135 that the relative advantages and disadvantages of a Channel Tunnel cannot be measured by the views adopted in regard to it by specific industries and trades.

Paragraphs 116, 123 and 124.

(*c*.) I am satisfied that some considerable apprehension exists in the business community regarding the effect of a Tunnel as favouring imports. With one exception no Chamber has supported the Tunnel scheme save on quite general grounds, and no specific or tangible benefit has been claimed for it. On the contrary, some Chambers have expressed definite opposition. Further, no trade has expressed any active desire for it.

Paragraphs 117 to 119.

(*d*.) So far as employment is concerned, I believe that the temporary gain during the period of construction would be more than counteracted by the permanent loss of employment which must necessarily follow. I need not repeat the figures already given in paragraphs 96 to 99 of the Report, but I do think it worthy of note that a number of the men likely to be permanently displaced are members of our mercantile marine. This would, I think, be a regrettable result; and one which is well worth while avoiding.

Paragraphs 96 to 99.

I have now stated as fairly and clearly as I can the arguments for and against the scheme as I understand them. The result seems to me to be that the advantages claimed are speculative in nature and quite indefinite as to extent. The disadvantages, on the other hand, though I have no desire to magnify them beyond their due proportion, are definite and traceable to ascertainable trades and industries.

There is one further point I wish to add. In the case of an island people such as ourselves it is advisable to keep open all possible channels of communication. Further there are certain advantages in this quality of insularity, and to make this country a mere adjunct to the continent might well promote a feeling of unrest by adding to our anxieties and responsibilities.

This is a psychological factor which, in my view, should be borne in mind as likely, under certain conditions, to react unfavourably on the general life and trade of the nation.

My general conclusion is that even if a Tunnel could be built, maintained and operated by private enterprise, and if it could carry traffic at competitive rates, any resultant advantages are uncertain and, at the best, slight in extent, whilst, on the other hand, evidence submitted has shown that there would be a definite detriment to substantial portions of established industries, such, for instance, as Shipping and Agriculture.

After hearing all the evidence and taking all the conditions into consideration, I am therefore opposed to the scheme on economic grounds.

(Signed) EBBISHAM.

2, *Whitehall Gardens, S.W.* 1,
February 28, 1930.

APPENDIX I.

Report to the Channel Tunnel Sub-Committee by Livesey, Son and Henderson, MM.Inst.C.E., Mott, Hay and Anderson, MM.Inst.C.E., Rendel, Palmer and Tritton, MM.Inst.C.E.

To the Chairman and Members of the Channel Tunnel Sub-Committee, Committee of Civil Research, 2, Whitehall Gardens, London, S.W.1.

Gentlemen,

CHANNEL TUNNEL.

As requested, we have carefully considered the question of the construction of the above tunnel. We have examined the plans and sections and studied the evidence placed at our disposal by your Committee.

Taking the questions put to us in the order they appear in the "Terms of Reference," we have the honour to report as follows :—

1 (a), (i and ii). **"Is a Channel Tunnel Feasible of Construction, Maintenance and Operation?"**

In considering the *Feasibility of Construction*, we need hardly say that this will depend upon the nature of the ground to be tunnelled through.

It appears to be generally accepted by the geologists who have studied the scheme that the beds of chalk showing on the cliffs and disclosed by shafts on both sides of the Channel (and by the soundings and surface samples across the Channel itself) do in all probability extend across the Straits. The evidence of Sir John Flett, Mr. John Pringle, M. Javary, and the Official French Report put in by Baron d'Erlanger all point to this conclusion; but none of the witnesses is able to say that the tunnel can be driven (24 miles in length under the sea) without meeting with fissures or infilled valleys.

The existence of these cannot be said to have been either proved or disproved by the soundings and surface samples referred to above. These samples may have been numerous enough for the geologists to determine approximately the outcrops of the various strata, but reliance cannot be placed upon them for more than that.

If large fissures filled with rough gravel and in direct communication with the sea were met with the difficulty of tunnelling through them would be very serious, and we are of the opinion that the risk of such a contingency cannot be disregarded.

Compressed-air working could not be resorted to as the pressure equivalent to the head of water would be so great that it would not be a practicable proposition.

Freezing the Ground in front of the face has been suggested; but from all we know of this process we are doubtful of its success in dealing with the difficulty.

There is also the process of *Cementation*. This consists of pumping cement grout into the fissures through pipes kept well in advance of the tunnel. This system has been used—though not with uniform success—in a great number of different situations, sometimes using pressures up to as much as 2,000 lbs. per square inch. If fissures, filled with rough gravel and therefore affording fairly free passage for the sea water, were met with, our view would be that cementation would probably seal them up; on the other hand, if close sand were met with, yet yielding large quantities of water, the conditions would be more difficult and the success of the process doubtful.

We feel, however, that with the development of engineering resources, fissures, unless of exceptional size, would not present any insuperable difficulty. On the other hand, if an infilled valley were encountered (so deep that the tunnel would come out of the chalk) charged with water at a pressure of, say, 150 lbs. per square inch, the position would be very serious. We hesitate to say that the project would have to be abandoned, as it might be possible to deal with it by adopting a shield with an entirely closed face, such as was designed by the late Mr. J. H. Greathead; the excavation being removed by powerful water jets and washed through controlled pipes in the bulkhead. This, however, has never been tried except experimentally, and we are not aware of any tunnel which has been driven under such conditions as we have outlined above.

As regards the *Maintenance of the Tunnel*, we see no reason to apprehend any difficulty. The tunnels would be lined throughout, and in the sections where the ground contained water the joints of the lining would be caulked. Small leakages would no doubt occur, and the water would be led to the drainage headings referred to later and pumped.

The *Maintenance of the Permanent Way* would also not present any serious difficulty. There is less corrosion of the rails, &c., in a tunnel where the traffic is worked electrically than in the open. The inspection and repair of the tracks would have to be carried out mainly at night, and a careful organisation would have to be arranged for the transport of men and materials.

We see no reason to apprehend difficulty in connection with the

Operation of the railway. Electric traction and automatic signalling would, of course, be adopted. The running of the trains themselves would probably create enough ventilation, which could be regulated by openings into the pilot tunnel (to which reference is made later) as found necessary. If this were insufficient, it could be supplemented by propellor fans, the pilot tunnel being used to convey air to the running tunnels.

During the period of construction the supply of fresh air to the men at each face would require careful consideration and would be a matter of considerable expense throughout the operations.

The plan and section (Drawing No. C.T.1*) accompanying this report shows the suggested centre-line of the tunnel and the strata which it is expected will be met with on that line. Sir John Flett and Mr. Pringle are of the opinion that the line shown will permit of the construction of the tunnel in the lower chalk, which it is agreed is the best medium.

We have shown the proposed level of the tunnel on the section, but this can be varied if found advisable after the driving of the pilot tunnel.

(b.) **"Is a Pilot Tunnel Necessary or Advisable, and how long would it take to construct?"**

We think a *Pilot Tunnel* is absolutely necessary, and, in addition, we advise that drainage tunnels should be provided.

The *Pilot Tunnel* should be driven near the centre-line from shore to shore and at about the same level as the future main tunnels. As it proceeded, advance and radial boreholes should be driven from it to explore the ground ahead and all round it so that the fullest information would be obtained regarding the ground through which the main tunnels would subsequently be driven.

This information could not be obtained from the drainage tunnels for reasons given later.

We think the pilot tunnel should not be less than about 12 feet internal diameter, instead of 10 feet suggested by the Promoters and the Southern Railway Company. A 12-feet tunnel would provide sufficient width for the temporary railways which would be required for the construction of both the pilot tunnel and the main tunnels and space for the pipes used for ventilation and other purposes during construction.

The disposal of the spoil from the main tunnels would be effected through the pilot tunnel. Junctions would be made to each main tunnel at, say, every two miles, so that construction could proceed simultaneously at many points on each half of the Channel.

The *Drainage Tunnels* should be made 7 feet internal diameter, with a gradient falling to the shore shafts, in order that if water were encountered suddenly, it would flow by gravitation to the pumps, and so would not impede the escape of the workmen through the pilot tunnel. To obtain this falling gradient the drainage tunnels

* Note.—Drawing No. C.T. 1 is reproduced as Appendix IV.

must of necessity diverge from the centre-line of the tunnels owing to the dip in the chalk, and for this reason could give no information as to the ground in the neighbourhood of the main tunnels.

If the pilot tunnel were to be used for drainage at the shore ends, pumping would have to be carried out up a rising gradient several miles in length and in a very restricted space. There would also be a risk of a breakdown of the pumping arrangements and consequent flooding of the working face.

The drainage tunnels might possibly merge into the pilot tunnel at about 9 miles from each shore—reliance being placed thenceforward upon the pilot tunnel to deal with any water met with. The estimate of cost, however, provides for the drainage tunnels throughout.

Connections would be made at fairly frequent intervals between the pilot tunnel and the drainage tunnels.

We estimate that the pilot and drainage tunnels could be driven in about 5 years; rotary excavators being employed in both cases.

We are aware that estimates have been given for carrying out this work in a shorter period of time, but our experience with many different types of boring machines over long distances is such that we consider it is unwise to rely upon the work being carried out more speedily.

(b) (i). **"Is further Exploratory Work required before beginning work on the Pilot Tunnel?"**

(b) (ii). **If so, what further work should be done, how long would it take, and approximately how much would it cost?"**

We think that the areas over which, apparently, no soundings and surface samples were taken should be explored in the same way, but not necessarily to the same extent, as the rest of the Channel bed has been done. Sir John Flett and Mr. Pringle both agree that this is advisable.

We would not rely on these soundings and samples by themselves any more than we do on those already taken; but they may disclose useful information.

It has been ascertained that if this work were carried out by one of H.M. Surveying Ships the time occupied would not be more than one or two months, given fine weather.

Borings in the Channel have been proposed, and while it would be very satisfactory to have confirmation of the opinions of the geologists as to the thickness of the strata extending from shore to shore, the borings could not, in our opinion, give the information required for the tunnel project. They could not, except at enormous expense, be made at frequent intervals, and even then there would be no certainty that fissures or infilled valleys did not exist between them.

(c.) **"If and when a Pilot Tunnel had been successfully made would it be possible to estimate for the Main Tunnels with reasonable certainty as to time, cost, and any unusual difficulties to be overcome?"**

If the ground through which the main tunnels are to be constructed were thoroughly explored by borings from the pilot tunnel as described in Section 1 (b) of this report, and the ground proved to be satisfactory, the answer to the questions is in the affirmative. The main tunnels could be completed and equipped in about 3 years, after the Pilot tunnel had been finished.

(d) (i). **"The Promoters and the Southern Railway Company suggest that £5,000,000* would cover the cost of constructing a Pilot Tunnel with a diameter of 10 feet; and £25,000,000 that of two Traffic Tunnels with a diameter of 18 feet 6 inches of a total length of 34 miles† (including 12 miles of Approach Tunnels).**

"This estimate does not include provision for the cost of Constructing the Exchange Stations at each end of the Tunnel or the cost of the Electric Locomotives.

"Are you able to say that this is a not unreasonable estimate?"

Our estimate of the cost of driving the pilot tunnel, 12 feet diameter, the drainage tunnels and their shafts, together with the connections between the pilot and drainage tunnels is £5,600,000.

We estimate that the cost of the whole scheme, including the pilot tunnel, the drainage tunnels, the connections between the pilot tunnel and the main tunnels, together with the land tunnels and open approaches will amount to £30,900,000, of which amount £450,000 represents the cost of the open approaches on both sides.

Our estimates provide for disposal of the excavation by specially designed waggons and dumping into the sea. They include the construction of the works, permanent way, electrical equipment, sub-stations, signalling, &c., but do not include the cost of exchange stations, electric locomotives, electric generating stations, or land.

The equipment would provide for a 10 minutes service if such is found necessary at certain times of the day.

It will be seen from the above figures that we are in substantial agreement with the estimate of the Promoters and of the Southern Railway Company.

Drawing C.T. 1 accompanying this report shows the connection to the Southern Railway at Sandling Junction at the point indicated

* At a date subsequent to the drafting of the terms of reference, the Southern Railway informed the Channel Tunnel Committee that their revised estimate for the whole Pilot Tunnel was £6,000,000.

† This length should be 36 miles.

on the plan furnished to us by Mr. Ellson, the Chief Engineer of the Southern Railway Company. We have discussed this part of the scheme with Mr. John Pringle and he is of opinion that very great difficulty would be experienced in constructing the approach tunnels as shown owing to the disturbed state of the ground west of Shakespeare Cliff, and he would recommend a deviation which would avoid the disturbed ground. The consideration of this part of the project would not materially affect the estimate of cost, and we have not therefore put forward any alternative connection.

(d) (ii). **"The Chemin de Fer du Nord have informed us that, in their view, if the Fougerolles', or some similar, method were successfully adopted for disposing of the excavated material, the cost of constructing the Traffic Tunnels would be reduced to (say) £18,000,000 and the period of construction to 5 years from the date on which work was started on them.**

"Do you consider this system to be a practical one and these estimates to be well founded?"

We regret we are unable to give the Committee any definite assistance as to the Fougerolles' or similar method for the disposal of the spoil. It is probable that some such method might considerably reduce the cost of construction, but until trial of it is made under conditions similar to those which would obtain in the actual construction of the tunnel, there is no real information available.

It is stated in the Official French Report that M. Fougerolles would be willing to enter into a contract (under reserve) to construct the "reconnaissance gallery," 3 metres in diameter, 48 kilometres in length (30 miles), in 16 months, for the sum of 25,000,000 francs. We are unable to credit this, even on the basis of pre-war costs and pre-war value of the franc.

We have had an interview with the representatives of M. Fougerolles, who gave us full information about his proposals, and answers to questions which we put to them.

Briefly, M. Fougerolles would employ a rotary tunnelling machine similar in principle to those used on the London underground railways, and in the experimental headings driven in the chalk in the Folkestone cliffs and under the sea at Shakespeare Cliff. These machines can be made to excavate the ground at such a speed that difficulty has hitherto been found in disposing of the spoil in the ordinary way. M. Fougerolles proposes to overcome this difficulty by mixing the débris with water in such proportions as would reduce it to a slurry capable of being pumped up on to the bed of the sea. To do this borings would be made to the sea bed, lined with steel tubes. Sea water is to be admitted by these tubes for use in spraying the face of the excavation and in reducing the débris to the consistency required for pumping.

The scheme has been worked out in considerable detail, and if it can be shown to be practicable, the saving in cost would be large.

We understand that the shaft for experimental heading driven from the English shore about the year 1880 has been filled up,

but that the shaft and heading on the French side remain as they were except that they are full of water which has drained in from the sea and from the land. It has, therefore, occurred to us that the water could be pumped out and a thorough test of M. Fougerolles' proposals made.

It was represented to us that M. Fougerolles would undertake to carry out the work involved in this test for the sum of £40,000, including the cost of the tunnelling machine, which could afterwards be used for driving the pilot heading. This is on the assumption that no more difficult ground is encountered than already met with in the experimental heading on the French side.

In view of the saving which would be made if the system is successfully demonstrated, we are of opinion that the carrying out of the trial should receive consideration.

What view the Promoters would take of M. Fougerolles' proposal we are of course unable to say.

As to the saving in time which might be brought about by the adoption of the method, we find ourselves unable to make any statement. The progress of the work would be measured under this system (if successful) not by the disposal of the spoil, but by the time taken to erect the lining. We think it is essential that the tunnels should be lined as they progress.

We have described M. Fougerolles' scheme for the disposal of the spoil, but it should not be assumed that, if it is unsuccessful, no other method, except by waggons, is practicable. If there is found to be no difficulty in reducing the spoil to a slurry, it might be found feasible, by the addition of more water (obtained from the shore shafts), to make it flow through the drainage tunnel to the shafts, where pumping would be a comparatively easy matter.

(d) (iii). **"The Promoters allow the sum of £1,000,000 per annum for the Operation and Upkeep of the Tunnel.**

"Assuming that the Rolling-Stock and Electrical Locomotives will be owned and maintained by the Operating Railway Companies, is this sum, in your view, sufficient to cover all costs under this head?"

On the assumption that the electric locomotives and the rolling-stock will be owned and maintained by the operating Railway Companies, we are of opinion that the operation and upkeep of the tunnel will not reach a sum of £500,000 per annum.

(e.) **"How many men per annum would probably be employed (a) directly and (b) indirectly in the construction of the Pilot and Main Tunnels respectively?"**

The men employed in the construction *on each side of the Channel* would be about—

	Directly.	Indirectly.
On the Pilot and Drainage Tunnels	250	750
On the Main Tunnels—including Land Tunnels	1,550	4,500

2. **"To report generally on the problems connected with the Interchange of Rolling-Stock between the Railways of Great Britain and those of the Continent, both for Goods and Passenger Traffic."**

Interchangeability of passenger rolling-stock between the Continent and Great Britain is rendered difficult, as it may be stated, in general terms, that the Continental passenger stock is too wide and too high to run on the British railways. It therefore appears to be necessary that special passenger stock shall be built for the Tunnel Service, of such dimensions that it will run on the Southern Railway. This, however, does not mean that such stock will be to any great extent smaller than the ordinary modern Continental vehicles, as their width need only be 5 inches less than that of the most modern coach run in France, and the roof will have to be lowered to a slight extent. The generality of English coaches can be made, without great expense, to run on the Continental lines should this at any time be advisable.

With regard to waggon stock, the same remark applies, namely, that the majority of Continental stock cannot be run on British railways. There are a certain number of waggons on the Continent which, with a few small alterations, can doubtless be made available, but it will probably be necessary to construct special waggons for the Tunnel Service. If the goods traffic were small and localized, this method of dealing with it would be quite suitable, and is similar to the method adopted to-day by the Great Eastern Train Ferries. If the traffic grows to large dimensions, and if it were drawn from distant parts of Europe, it would appear difficult, if not impossible, to deal with it by means of special waggons; in which case, transhipment would have to be resorted to.

CONCLUSIONS.

A summary of our conclusions would be as follows:—

(1.) The *Feasibility of Construction of the Tunnel* depends upon the nature of the ground to be tunnelled through. No definite opinion can be given until the ground has been proved by the construction of the pilot tunnel. Difficulties would no doubt be encountered, but we hesitate to say that they would be insurmountable.

(2.) There is no difficulty as to the *Maintenance* of the tunnel, the *Permanent Way* or the *Operation* of the railway.

(3.) *A Pilot Tunnel* is necessary to test the ground, and should be made large enough to give room for temporary railways and ventilation pipes; when complete it would be used for the evacuation of the spoil from the main tunnels—junctions being made at intervals for this purpose. Permanently it would be used for electric

cables, &c., as a duct for providing supplementary ventilation if found necessary, and, finally, as access for inspection and maintenance of electrical equipment, permanent way and signals.

(4.) *A Drainage Heading* should be made with a gradient falling to the shore shafts; and connected to the pilot tunnel as required.

(5.) *The Pilot Tunnel and the Drainage Heading could be Driven Simultaneously*—the latter being kept in advance. The time required to construct these preliminary works would be about 5 years; another 3 years being needed for the construction and equipment of the main tunnels.

(6.) Our *Estimate of the Cost of the Pilot and Drainage Headings would be* £5,600,000; and for the *Main Tunnels and Equipment* (not including the Exchange Stations, Electric Locomotives, Generating Stations or Land) £25,300,000—total £30,900,000.

(7.) We think that M. Fougerolles' proposal, if successfully demonstrated, might result in considerable saving of cost, and a trial should receive consideration.

(8.) The sum per annum estimated by the Promoters for the operation and upkeep of the works is, in our opinion, much more than sufficient.

(9.) It will be seen from the Table given in Section 1 (e) that until the Pilot and Drainage Tunnels are completed, employment of a large number of men should not be expected.

We have to acknowledge the assistance given to us by Sir John Flett, Mr. Pringle and other members of the Geological Survey staff, all of whom have been very helpful. We have also to acknowledge the help received from Mr. Ellson, Chief Engineer of the Southern Railway Company, who has placed his drawings at our disposal.

We have the honour to be,
Your obedient Servants,

(Signed) LIVESEY, SON AND HENDERSON.
MOTT, HAY AND ANDERSON.
RENDEL, PALMER AND TRITTON.

9, Iddesleigh House,
Caxton Street, Westminster, London, S.W. 1,
December 6, 1929.

APPENDIX II.

List of Witnesses.

ate of Meeting.	Name.	Description of Witness.
April 19, 1929 ...	Sir Cyril Hurcomb, K.B.E., C.B.	Secretary, Ministry of Transport.
	Col. Sir John Pringle, C.B.	Chief Railway Inspecting Officer, Ministry of Transport.
	Mr. E. W. Rowntree, C.B.E.	Assistant Secretary, Ministry of Transport.
	Lt.-Col. A. H. L. Mount, C.B.E.	Railway Inspecting Officer, Ministry of Transport.
	Mr. T. Shirley Hawkins, O.B.E., M.Inst.C.E.	Civil Engineer, Ministry of Transport.
April 26, 1929 ...	Sir Sydney Chapman, K.C.B., C.B.E.	Chief Economic Adviser to His Majesty's Government.
April 29, 1929 ...	Mr. John Pringle (on behalf of Sir John Flett, K.B.E.)	Senior Geologist, Geological Survey of Great Britain.
May 3, 1929 ...	The Rt. Hon. Sir William Bull, Bart., M.P.	Chairman of the Channel Tunnel Parliamentary Committee.
	Sir Arthur Fell	Late Chairman of the Channel Tunnel Parliamentary Committee.
	Accompanied by— Mr. Robin B. d'Erlanger.	
May 6, 1929 ...	Baron Emile B. d'Erlanger	Chairman, Channel Tunnel Company.
	Mr. Robin B. d'Erlanger	
May 10, 1929 ...	Sir Brodie Henderson, K.C.M.G., C.B., M.Inst. C.E.	President, Institution of Civil Engineers.
May 13, 1929 ...	Sir Herbert Walker, K.C.B.	General Manager, Southern Railway.
	Accompanied by— Mr. W. Bishop	Solicitor to the Southern Railway.
May 24, 1929 ...	Mr. C. E. R. Sherrington	Secretary, Railway Research Service.
May 27, 1929 ...	Mr. Basil Mott, C.B. ...	Partners in Messrs. Mott, Hay and Anderson, Consulting Engineers.
	Mr. David Hay	
May 31, 1929 ...	Mr. Carrol Romer, M.C....	Editor, "The Nineteenth Century and After."
June 3, 1929 ...	Sir Ernest Moir, Bart., M.Inst.C.E.	Partner in Messrs. S. Pearson and Son, Ltd., Contractors for Public Works.
July 1, 1929 ...	Air Vice-Marshal Sir Sefton Brancker, K.C.B., A.F.C.	Director of Civil Aviation, Air Ministry.

Date of Meeting.	Name.	Description of Witness.
July 5, 1929 ...	Sir Ralph Wedgwood, C.B., C.M.G.	Chief General Manager, London and North-Eastern Railway.
	Accompanied by— Mr. H. Allaway ...	Assistant General Manager (Shipping), London and North-Eastern Railway.
July 8, 1929 ...	Sir Charles Howell Thomas, K.C.B., C.M.G.	Permanent Secretary, Ministry of Agriculture and Fisheries.
	Accompanied by— Mr. R. C. Hinton ...	Marketing Investigator, Ministry of Agriculture and Fisheries.
July 11, 1929 ...	Monsieur P. E. Javary ...	Managing Director of the French Channel Tunnel Committee and General Manager, *Chemins de fer du Nord.*
	Accompanied by— Monsieur J. Rieter ...	*Correspondant à Londres, Chemins de fer du Nord.*
July 12, 1929 ...	Sir Herbert Walker, K.C.B.	General Manager, Southern Railway.
	Accompanied by— Mr. C. W. Cooper ...	Deputy Continental Assistant, Southern Railway.
July 15, 1929 ...	Mr. H. H. Dalrymple-Hay, M.Inst.C.E.	Civil Engineer.
October 4, 1929	Sir William Lobjoit, O.B.E., J.P.	Chairman of the Fruit and Vegetables Committee of the National Farmers' Union.
	Mr. A. G. Linfield ...	Chairman of the Glasshouse Growers' Sub-Committee of the National Farmers' Union.
	Accompanied by— Mr. E. C. Boughton ...	Secretary of the Fruit and Vegetables Committee of the National Farmers' Union.
	Sir Evan D. Jones, Bart	Governing Director, Messrs. Topham Jones and Railton (1926), Limited, Public Works Contractors.
October 14, 1929 ...	The Right Hon. the Earl of Crawford and Balcarres, K.T.	
October 16, 1929 ...	Sir Josiah Stamp, G.B.E.	Chairman and President of the Executive, London, Midland and Scottish Railway.
Nov. 4, 1929 ...	Mr. G. Ellson	Chief Engineer to the Southern Railway.
	Monsieur Garcey ...	Head of the Commercial Branch, *Compagnie internationale de Wagons-Lits.*
	Accompanied by— Mr. Stanley Adams ...	Director of Messrs. Thomas Cook and Sons.

Date of Meeting.	Name.	Description of Witness.
Nov. 11, 1929	Mr. C. T. Everist ...	London Manager, Bennett Steamship Company, Ltd. (nominated by the Chamber of Shipping of the United Kingdom).
	Accompanied by—	
	Mr. P. Maurice Hill ...	Assistant General Manager of the Chamber of Shipping of the United Kingdom.
	Dr. Isserlis	Chamber of Shipping of the United Kingdom.
	Col. Sir M. P. A. Hankey, G.C.B., G.C.M.G.	Secretary, Committee of Imperial Defence.
Nov. 25, 1929 ...	Mr. Harold Cox	
	Mr. W. Collard	Governing Director, The London and Paris Railway Promoters, Ltd.
	Accompanied by—	
	Mr. Theodore Stevens	
	Mr. Lennox Stanton	
Dec. 20, 1929 ...	Captain Paolo Coridori ...	
	Accompanied by—	
	Signor Joseph Grassi and Mr. T. W. Graham	
Feb. 3, 1930 ...	Sir Herbert Walker, K.C.B.	General Manager, Southern Railway.
	Accompanied by—	
	Mr. C. W. Cooper ...	Deputy Continental Assistant, Southern Railway.

APPENDIX III.

Imports and Exports through Dover, Folkestone and Newhaven.

Table I.—*Imports at Dover, Folkestone and Newhaven in* 1927.

Kind of Goods.	Dover.	Folkestone.	Newhaven.	Totals.
(A.)—*Perishable Goods.*	£'000.	£'000.	£'000.	£'000.
Fruit	15	781	89	885
Vegetables	29	336	128	493
Poultry and eggs	70	278	26	374
Fresh flowers	...	258	...	258
Yeast	68	...	...	68
Other goods	...	28	...	28
	182	1,681	243	2,106
(B.)—*Valuable and Fragile Goods.*				
Silk goods	5,161	444	1,083	6,688
Artificial silk goods	1,063	144	304	1,511
Apparel...	1,723	336	1,989	4,048
Fur skins, dressed, and manufactures	1,453	31	314	1,798
Wine	680	284	160	1,124
Fancy goods	474	128	410	1,012
Gold leaves	226	...	...	226
Clocks and watches	165	7	138	310
Embroidery	16	136	54	206
Works of art, books, &c.	...	53	92	145
Artificial flowers	81	13	155	249
Perfumery and essential oils ...	...	111	155	266
Other specified goods	116	37	154	307
	11,158	1,724	5,008	17,890
(C.)—*Other Foods, not perishable.*				
Butter	56	...	...	56
Cheese	...	405	16	421
Fruit	3	294	35	332
Meat	72	16	291	379
Cocoa preparations	...	782	...	782
Sugar goods	124	...	...	124
Other goods, specified	...	2	77	79
	255	1,499	419	2,173

Kind of Goods.	Dover.	Folkestone.	Newhaven.	Totals.
(D.)—*Other Goods.*				
Cotton goods	665	157	294	1,116
Woollen and worsted goods	3,220	192	706	4,118
Linen goods	41	18	...	59
Leather	220	128	227	575
Machinery	132	47	77	256
Wood and manufactures	119	49	131	299
Motor cars	71	127	343	541
Cycles	...	21	27	48
Rubber goods	17	8	91	116
Electrical goods	79	41	62	182
Tinfoil	...	67	...	67
Brass and copper goods	...	...	117	117
Paper	66	88	34	188
Buttons, &c.	...	32	48	80
Pipes	...	136	4	140
Coal	201	...	...	201
Other specified goods	100	107	161	368
All other goods	1,055	469	720	2,244
	5,986	1,687	3,042	10,715
Grand Totals	17,581	6,591	8,712	32,884

Table II.—*Exports of British Produce and Manufactures from Dover, Folkestone and Newhaven in* 1927.

Kinds of Goods.	Dover.	Folkestone.	Newhaven.	Totals
	£'000.	£'000.	£'000.	£'000.
Apparel	301	32	198	531
Cotton goods	608	80	249	937
Silk goods	90	13	113	216
Artificial silk goods	...	...	59	59
Woollen and worsted goods	1,345	48	671	2,064
Scientific instruments	38	11	72	121
Leather goods	67	13	224	304
Machinery	70	66	97	233
Paper	...	4	23	27
Rubber goods	20	27	128	175
Motor cars	37	33	80	150
Cycles	...	...	10	10
Books, pictures, &c.	37	24	97	158
Fur and other skins, dressed	76	253	128	457
Horses	...	101	...	101
Fish	...	189	39	228
Meat, fresh	...	118	3	121
Parcel post	1,812	...	...	1,812
Other specified goods	23	34	219	276
All other goods	474	157	497	1,128
	4,998	1,203	2,907	9,108

Table III.—*Exports of Imported Produce from Dover, Folkestone and Newhaven in* 1927.

Kinds of Goods.	Dover.	Folkestone.	Newhaven.	Totals.
	£'000.	£'000.	£'000.	£'000.
Silk and silk goods	27	62	120	209
Platinum	...	110	...	110
Pictures and works of art ...	...	22	88	110
Fancy goods	...	...	17	17
Butter	103	8	...	111
Meat	...	41	30	71
Cotton goods	...	3	4	7
Raw wool	3,607	94	9	3,710
Woollen and worsted goods ...	104	60	85	249
Apparel...	23	17	122	162
Skins and fur skins, not dressed ...	203	968	252	1,423
Skins and fur skins, dressed ...	70	372	102	544
Leather and manufactures ...	...	21	43	64
Scientific instruments	45	6	53	104
Machinery	18	13	33	64
Rubber goods	...	...	17	17
Wood manufactures	...	...	17	17
Bristles...	...	...	23	23
Other specified articles	...	15	61	76
All other articles	89	83	120	292
	4,289	1,895	1,196	7,380

LOWER CHALK

SURFACE

MIDDLE CHALK

Experimental Heading 7.0ft dia.

Existing shafts

Commencement of Channel Tunnel Railway
& Junction with The Southern Railway
(Charing Cross & Ashford Line)

SMEETH

ASHFORD

WESTENHANGER

SANDLING JUNCTION

HYTHE

SANDGATE

FOLKESTONE

Mouth of Tunnel

LYMINGE

WYE

ELHAM

ALKHAM

Existing Shafts

Experimental Heading 7.0ft. diameter

BARHAM

BISHOPSBOURNE

SHEPHERDS WELL

SOUTH CANTERBURY

CANTERBURY EAST

CANTERBURY WEST

BEKESBOURNE

ADISHAM

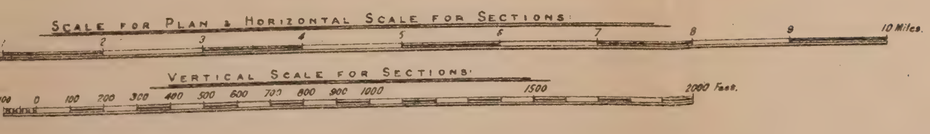
DOVER

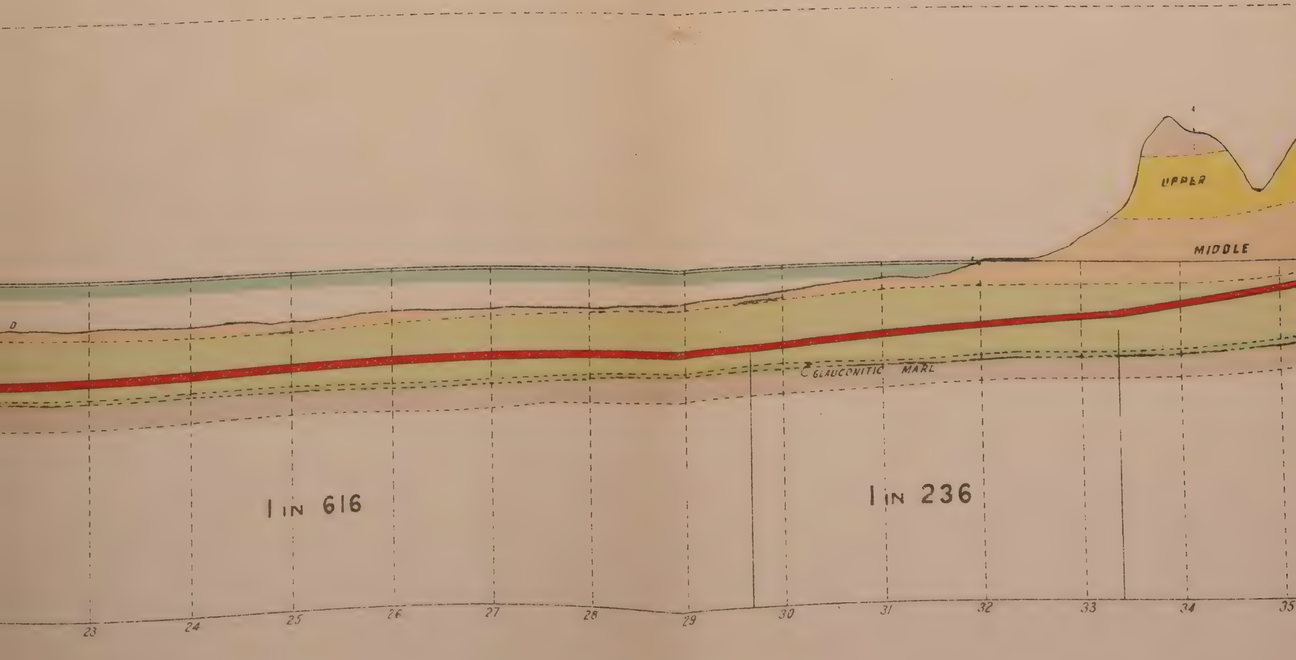
MARTIN

CROSS SECTION A. A.

SCALE: 24 FEET TO 1 INCH

POSED CHANNEL TUNNEL





SECTION

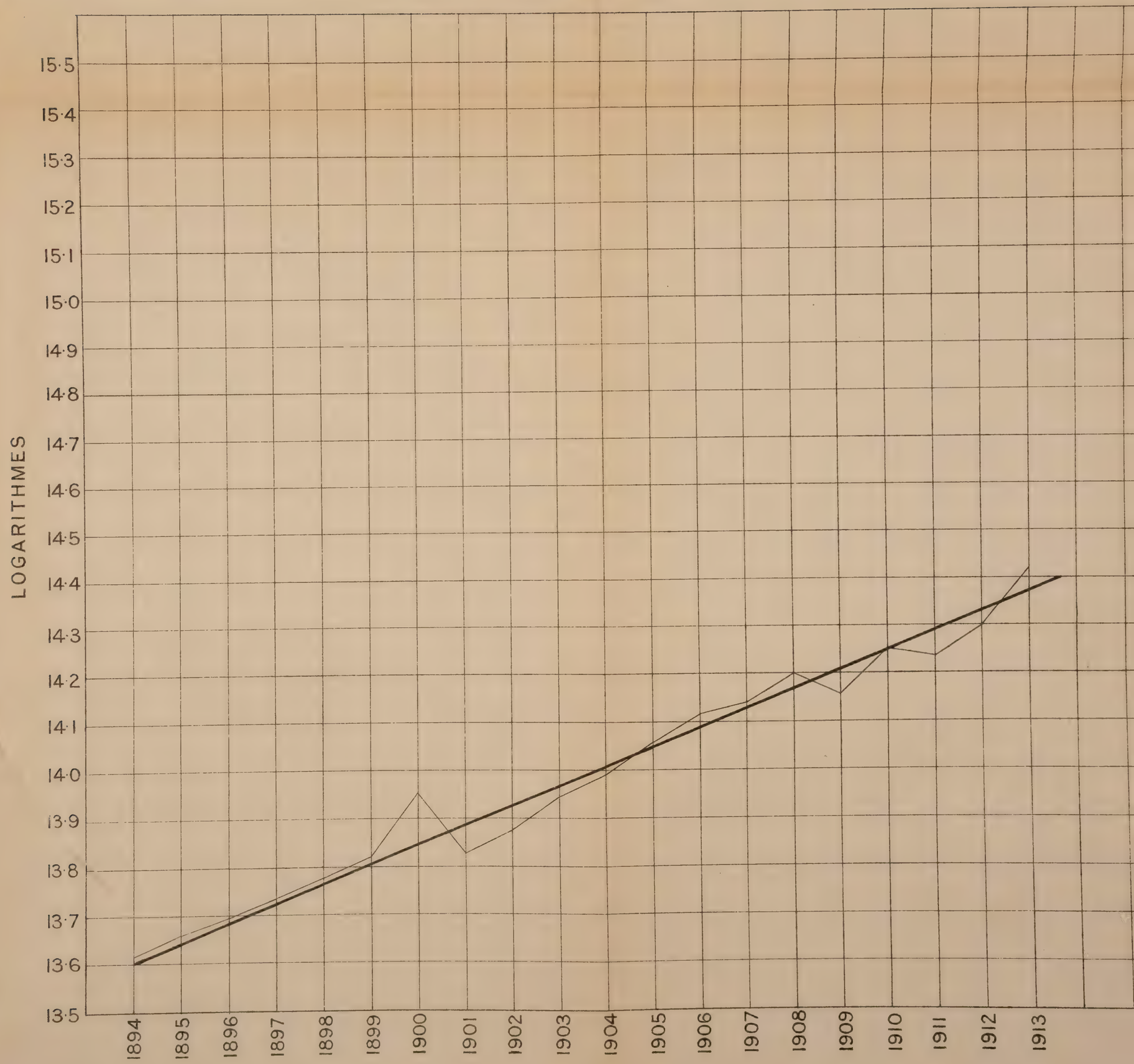
DRAWING No C.T.1.

9, Iddesleigh House,
Westminster, S.W.1.

TRAFIC VOYAGEUR

Logarithmes né

(Note: Les



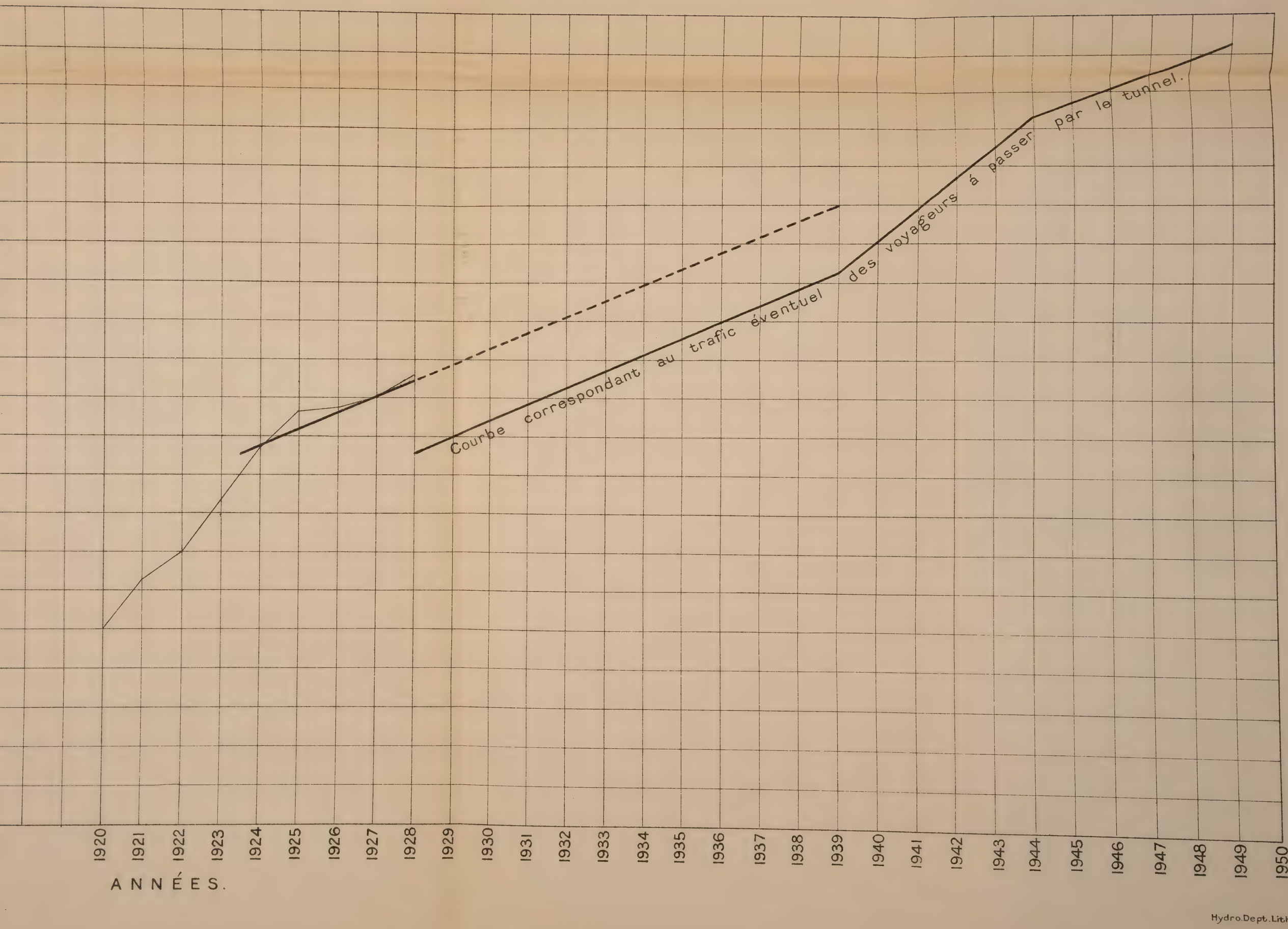
3520. WT 21580/2326. 70.2.30
3635. 2500.3.30

APPENDIX V

NTRE L'ANGLETERRE ET LE CONTINENT.

du nombre annuel des voyageurs de 1894 á 1928.

fins représentent la courbe réelle et les traits forts
la courbe moyenne.)



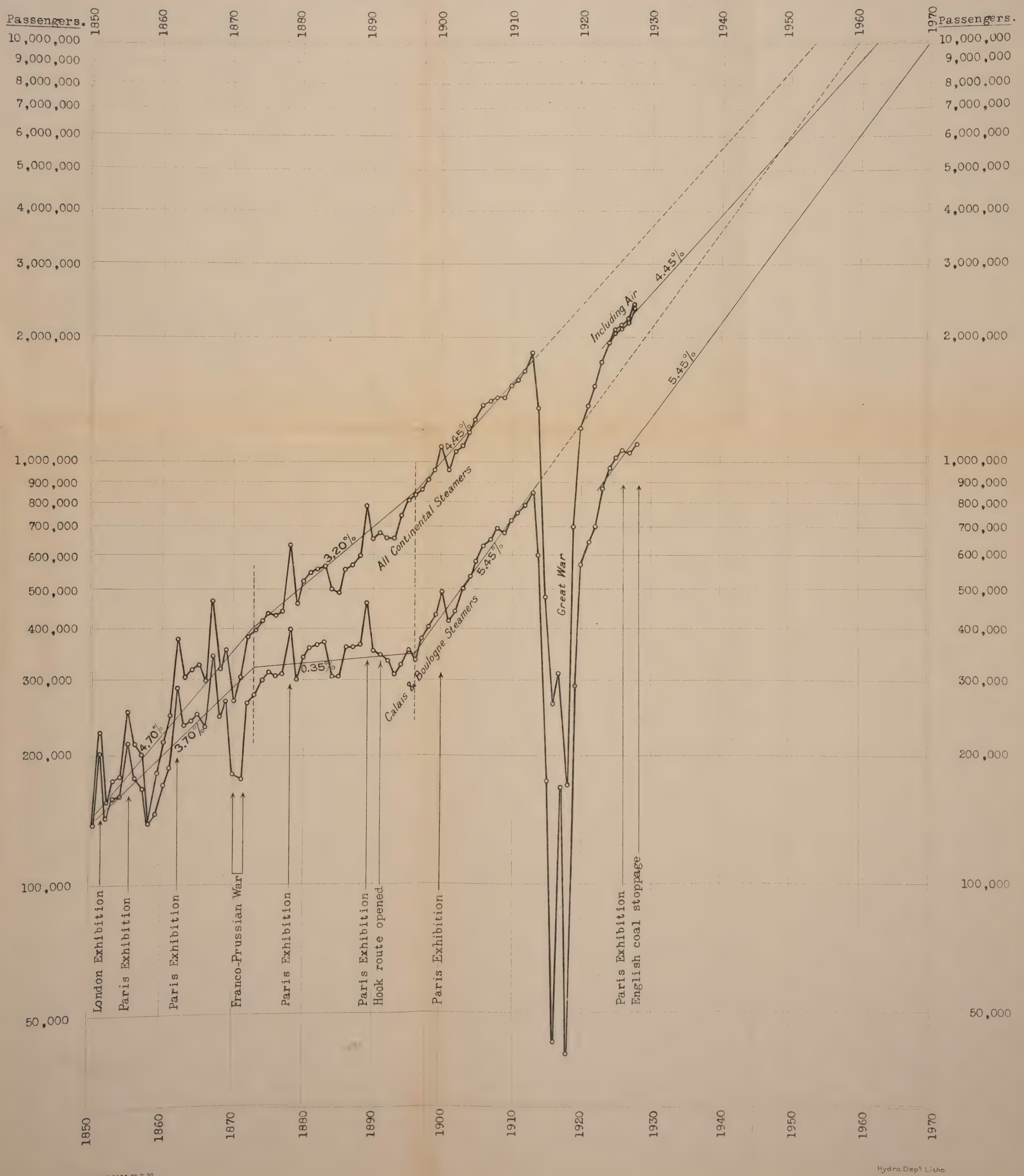
Hydro.Dept.Lith.

APPENDIX VI.

CROSS-CHANNEL PASSENGER TRAFFIC.

Graph on Geometric Scale showing the Compound Rates of increase per annum, based on figures furnished by the Southern Railway of number of passengers embarking and disembarking by the various Channel routes.

(Note: The heavier lines represent the actual annual rate of progression and the finer lines represent the average compound rate of increase.)

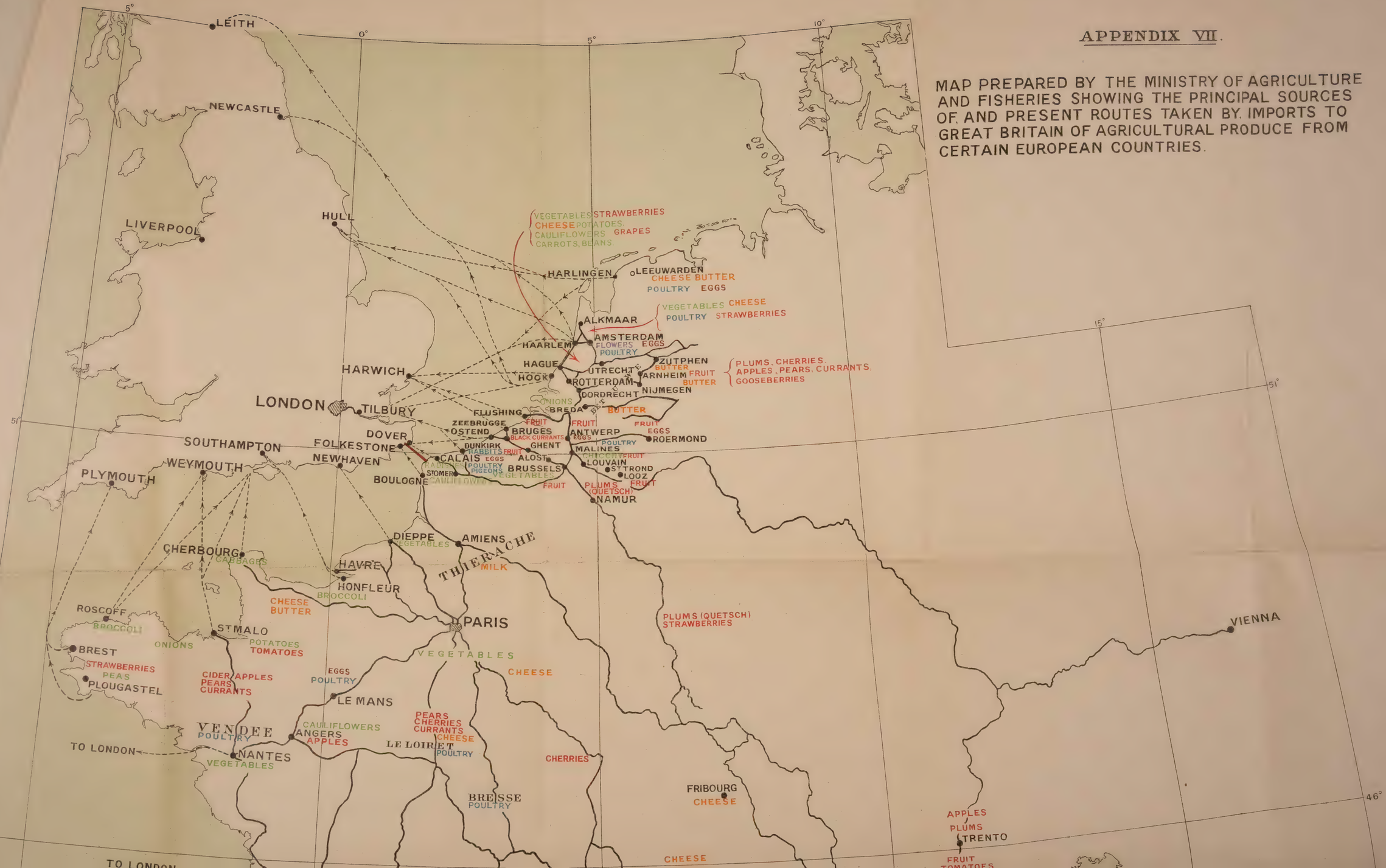


3382. W.T/4958. 2324. 70.2.30. 2500.330.

Hydro. Dept. Litho.

APPENDIX VII.

MAP PREPARED BY THE MINISTRY OF AGRICULTURE AND FISHERIES SHOWING THE PRINCIPAL SOURCES OF, AND PRESENT ROUTES TAKEN BY, IMPORTS TO GREAT BRITAIN OF AGRICULTURAL PRODUCE FROM CERTAIN EUROPEAN COUNTRIES.



VEGETABLES
STRAWBERRIES
CHERRIES
PLUMS
MONTAUBAN
CHEESE
POULTRY
HENDAYE
VEGETABLES
(ASPARAGUS)
CAVAILLON
AVIGNON
FLOWERS
PRIMEURS
(ASPARAGUS)
ALBENGA
GENOA
RIMINI
SAN MARINO
ANCONA
CAULIFLOWERS
PEARS
PLUMS
FLORENCE
PISA
APPLES
CAULIFLOWERS
LEGHORN
FLOWERS
PLUMS
CARCASSONNE
CHERRIES
MARSEILLES
VEGETABLES (LETTUCE)
CHERRIES
ROUSSILLON
PERPIGNAN
CERBERE
POULTRY PIGEONS
PLUMS
CHERRIES
PEARS
APPLES
VEGETABLES (BEANS, POTATOES)
TOMATOES
CHIETI
ROME
GRAPES
PLUMS
PEAS
CARROTS
TURNIPS
SPINACH
MATARO
NEW POTATOES
PLUMS
PEARS
BARCELONA
CHERRIES
PEARS
APPLES
NAPLES
PLUMS
CAULIFLOWERS
POTATOES
PEAS
CHERRIES
GRAPES
41
ONIONS
VALENCIA
GRAPES
POTATOES
MESSINA
PALERMO
TRAPANI
TOMATOES
GRAPES
POTATOES
CATANIA
SIRACUSA
TOMATOES
MURCIA
PLUMS
ASPARAGUS
SEVILLE
ONIONS
ONIONS
CARTAGENA
BIZERTE
TUNIS
ALGIERS
PHILIPPEVILLE
VEGETABLES
CONSTANTINE
VEGETABLES
ORAN
VEGETABLES
POTATOES
ARTICHOKES
TOMATOES
BEANS
PEAS
5°
0°
5°
10°
15°

Explanation of Colours.

Eggs	BROWN
Poultry	BLUE
Butter, Cheese, Milk	CHROME
Fruit	RED
Vegetables	GREEN
Flowers	VIOLET

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3248 Wt 8466/2330 70.1.30
3632. 2500 3 30

Hydro